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Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION

(NASA-CR-114624-Vol-2) ICE PACK HEAT SINK SUBSYSTEM - PHASE 1, VOLUME 2 (Hamilton Standard Div.) 84 p HC $6.25 CSCL 20M N73-31829 Unclas G3/33 13512

ICE PACK HEAT SINK SUBSYSTEM - PHASE I

VOLUME II

BY

GEORGE J. ROEBELEN, JR.

JUNE 1973

PREPARED UNDER CONTRACT NO. NAS 2-7011

BY

HAMILTON STANDARD

DIVISION OF UNITED AIRCRAFT CORPORATION

WINDSOR LOCKS, CONNECTICUT

FOR

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

AMES RESEARCH CENTER

MOFFET FIELD, CALIFORNIA 94035

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FOREWORD

This report has been prepared by the Hamilton Standard Division of the United Aircraft Corporation for the National Aeronautics and Space Administration's Ames Research Center in accordance with the requirements of Contract NAS 2-7011, Ice Pack Heat Sink Subsystem - Phase I.

Volume I contains the entire Ice Pack Heat Sink Subsystem - Phase I final report except for Appendix J, Ice Pack Heat Sink Subsystem Operating Instructions and Component Specifications.

Volume II contains Appendix J, Ice Pack Heat Sink Subsystem Operating Instructions and Component Specifications.

Appreciation is expressed to the NASA Technical Monitor, Mr. James R. Blackaby of the Ames Research Center, for his guidance and advice.

Hamilton Standard personnel responsible for the conduct of this program were Mr. F. H. Greenwood, Program Manager, and Mr. G. J. Roebelen, Program Engineer. Appreciation is expressed to Mr. J. S. Lovell, Chief, Advanced Engineering, Mr. P. F. Heimlich, Design Engineer, and Mr. E. H. Tepper, Analytical Engineer, whose efforts made the successful completion of this program possible.

APPENDIX J

ICE PACK HEAT SINK SUBSYSTEM OPERATING INSTRUCTIONS AND COMPONENT SPECIFICATIONS

TABLE OF CONTENTS

TABLE OF CONTENTS (Concluded)

LIST OF FIGURES

LIST OF FIGURES (Concluded)

PART I

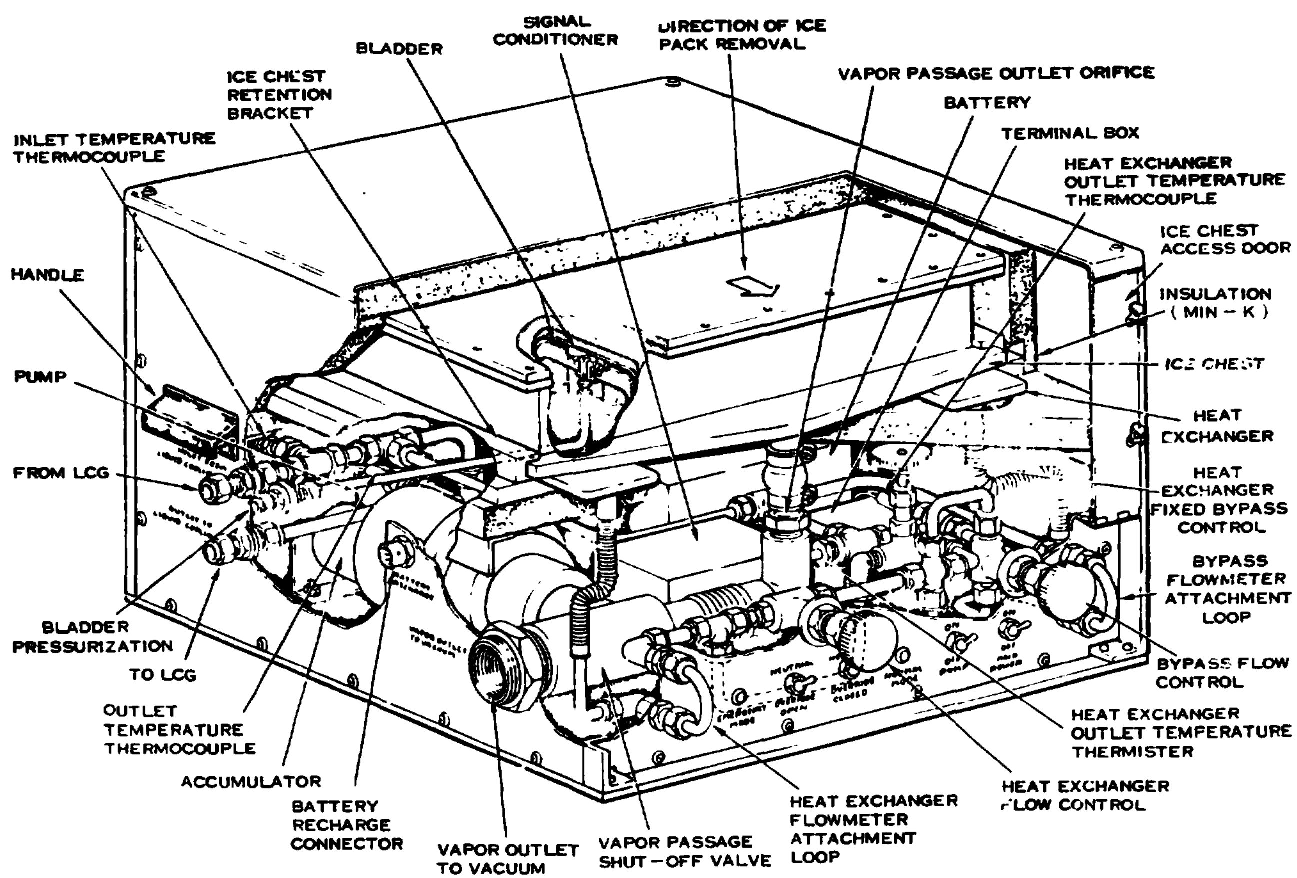
INTRODUCTION

INTRODUCTION

NASA Ames Research Center contract NAS 2-7011 authorized Hamilton Standard, Division of United Aircraft Corporation, to design, develop, and test at one-g a functional laboratory model (non-flight) Ice Pack Heat Sink Subsystem. This Operating Instructions and Component Specifications volume contains mechanical and electrical schematics, operating instructions, maintenance instructions, and mechanical and electrical component specifications.

PART II

OPERATION



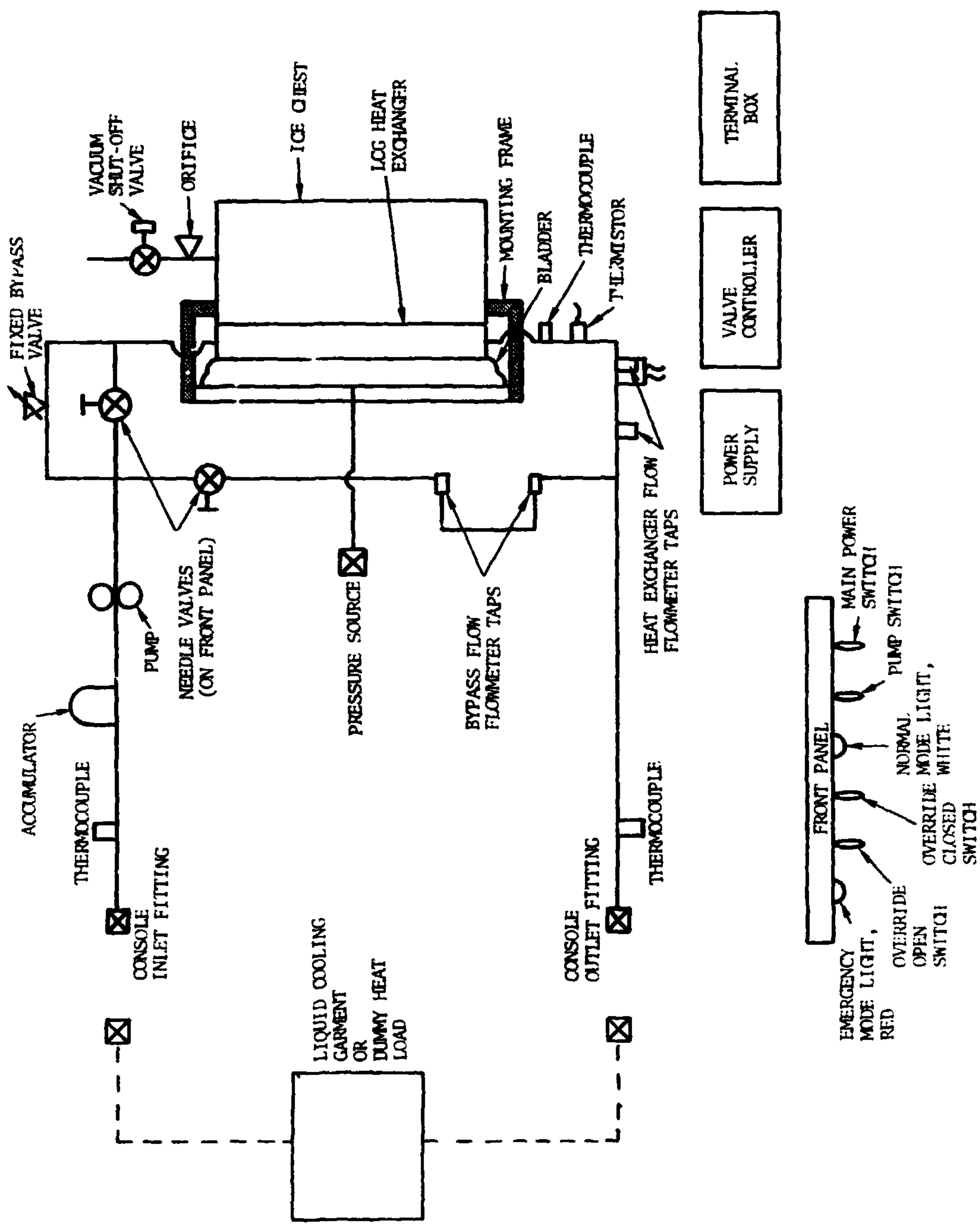
ICE PACK HEAT SINK SUBSYSTEM

FIGURE 1

OPERATION

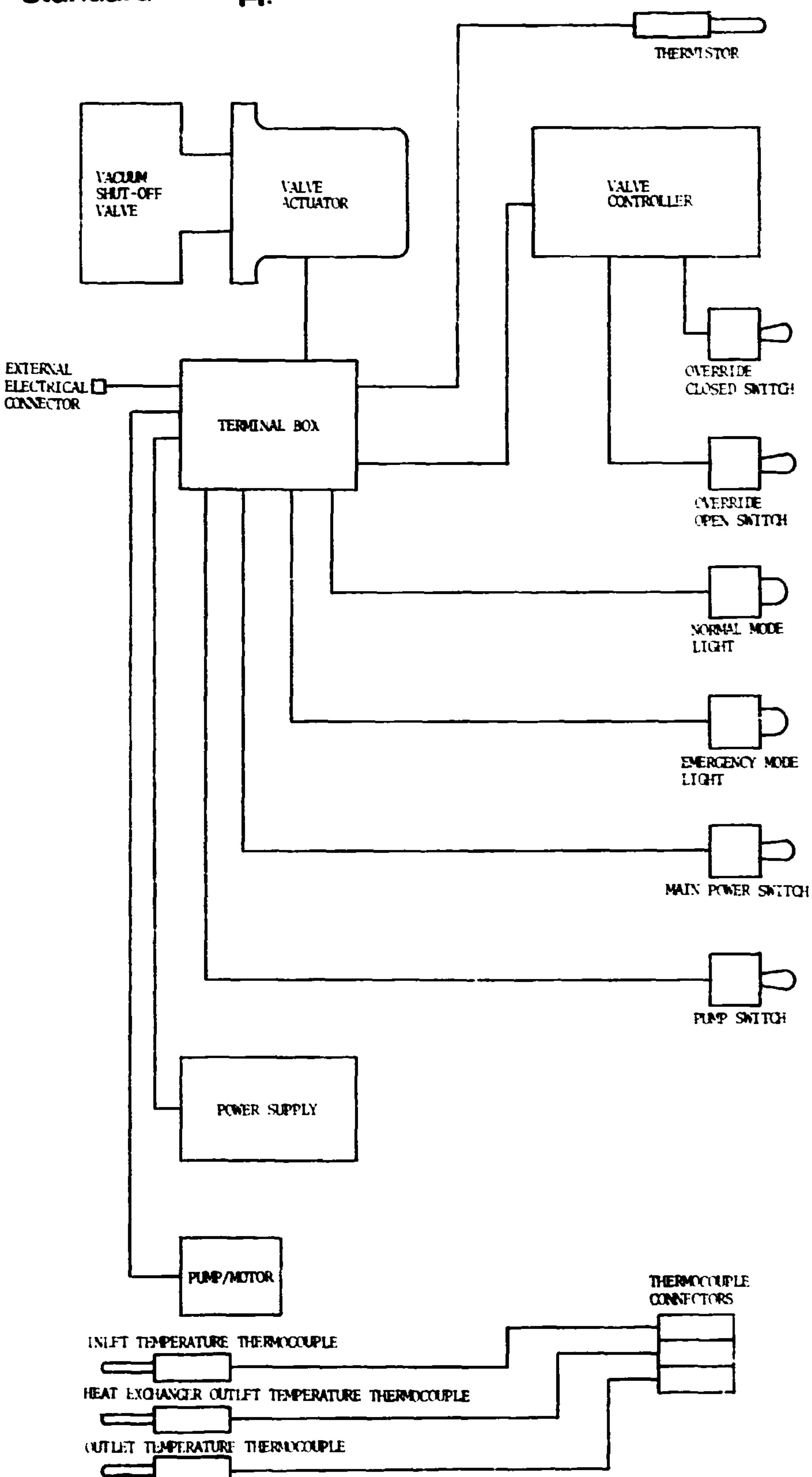
Prior to initial operation and after any penetration is made into the liquid coolant loop the Ice Pack Heat Sink Subsystem Console must be charged. Complete charging procedures are specified in Part III, Section A, Ice Pack Heat Sink Subsystem Console Charge and Maintenance.

Figure 1 presents an isometric drawing of the Ice Pack Heat Sink Subsystem. Figure 2 illustrates the Ice Pack Heat Sink Subsystem Schematic. Figure 3 illustrates the Ice Pack Heat Sink Subsystem Electrical Block Diagram. Figures 4, 5 and 6 illustrate front, left side, and rear views of the Ice Pack Heat Sink Subsystem Console. Figure 7 illustrates the Ice Pack Heat Sink Subsystem Console with the Ice Chest access door open.



ICE PACK HEAT SINK SUBSYSTEM SCHEMATIC

FIGURE 2

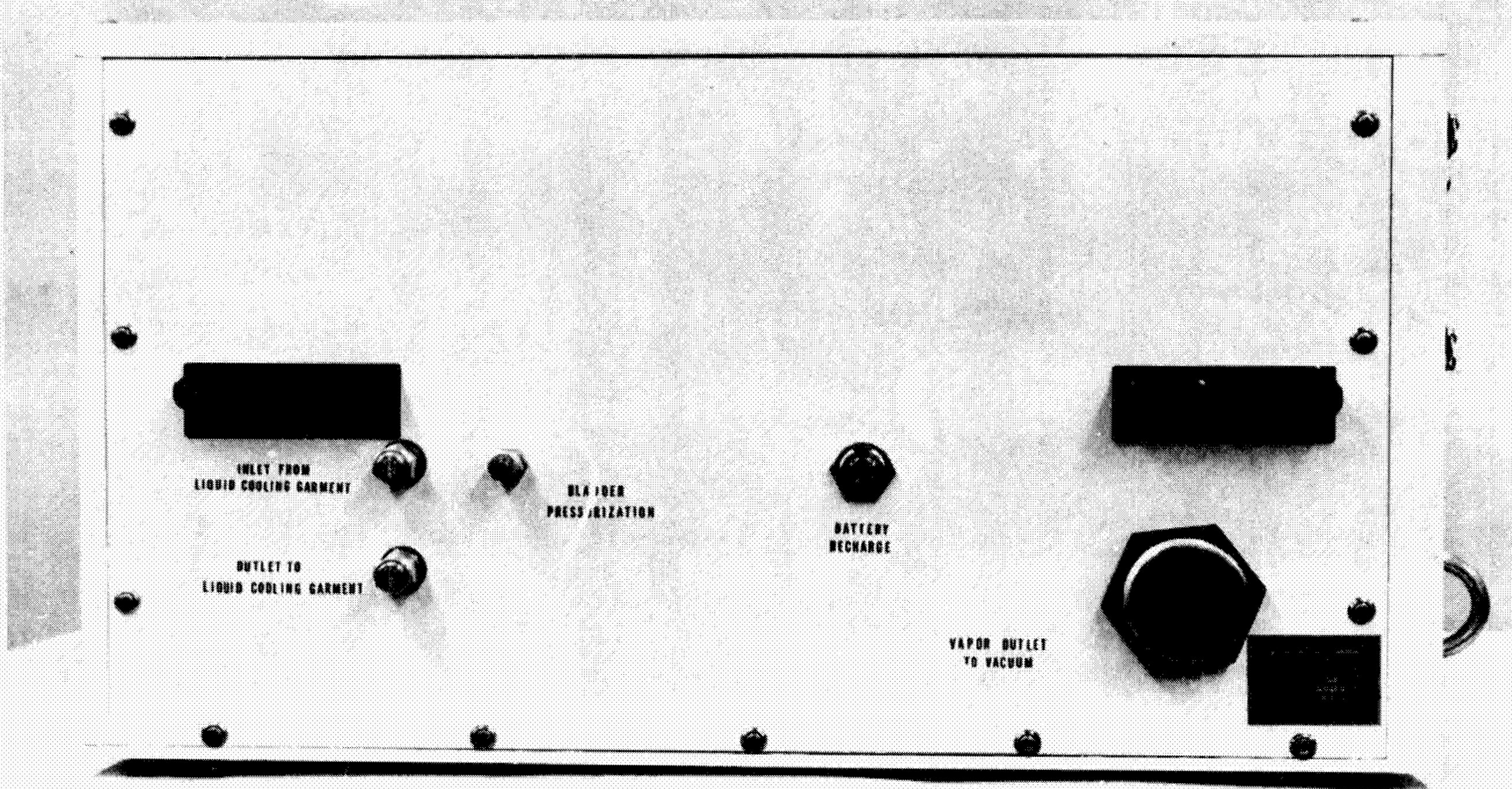


IC .CA HEAT SINK SUBSYSTEM
E CTRICAL BLOCK DIAGRAM

FIGURE 3

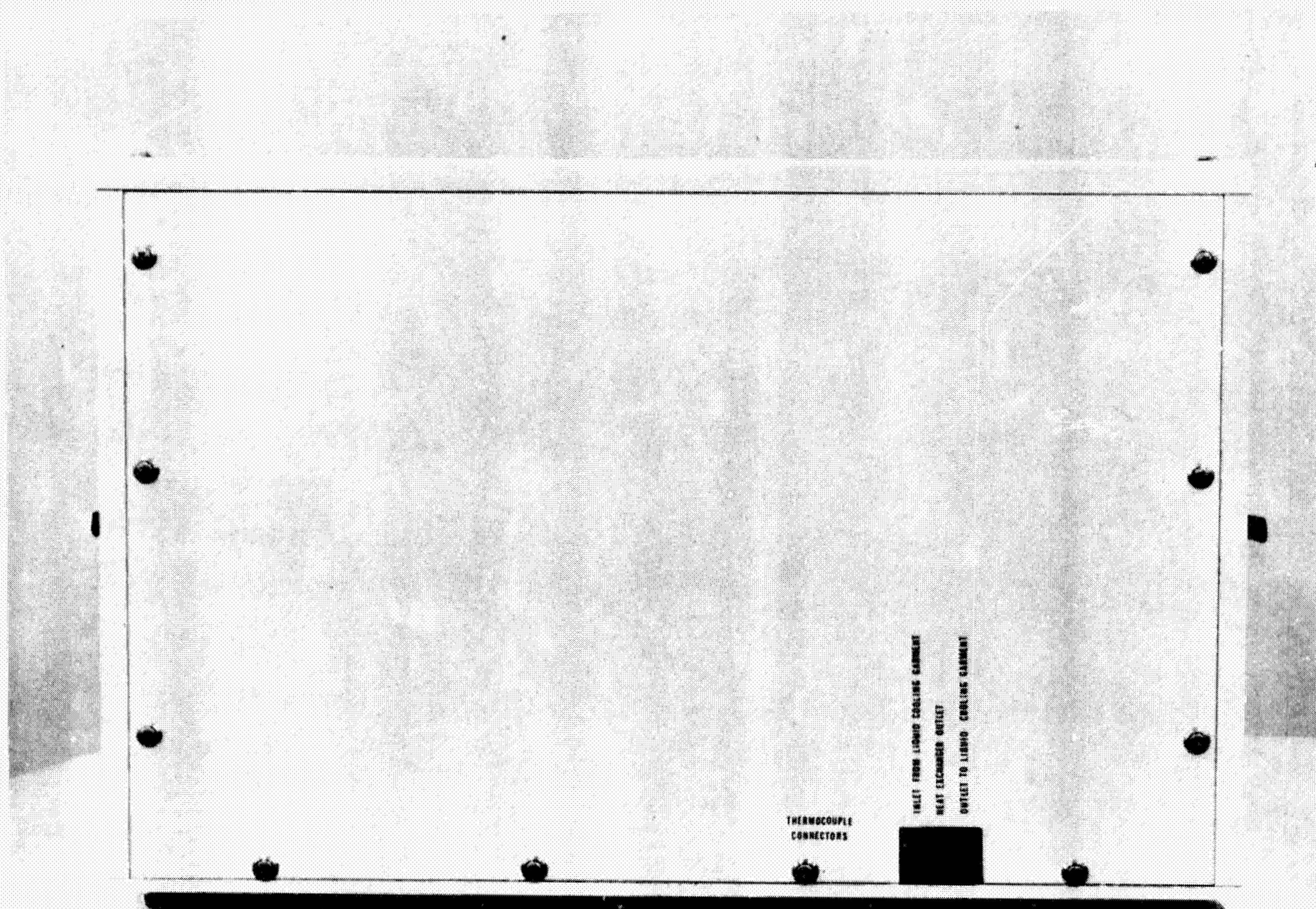
ICE PACK HEAT SINK SUBSYSTEM
FRONT VIEW

FIGURE 4



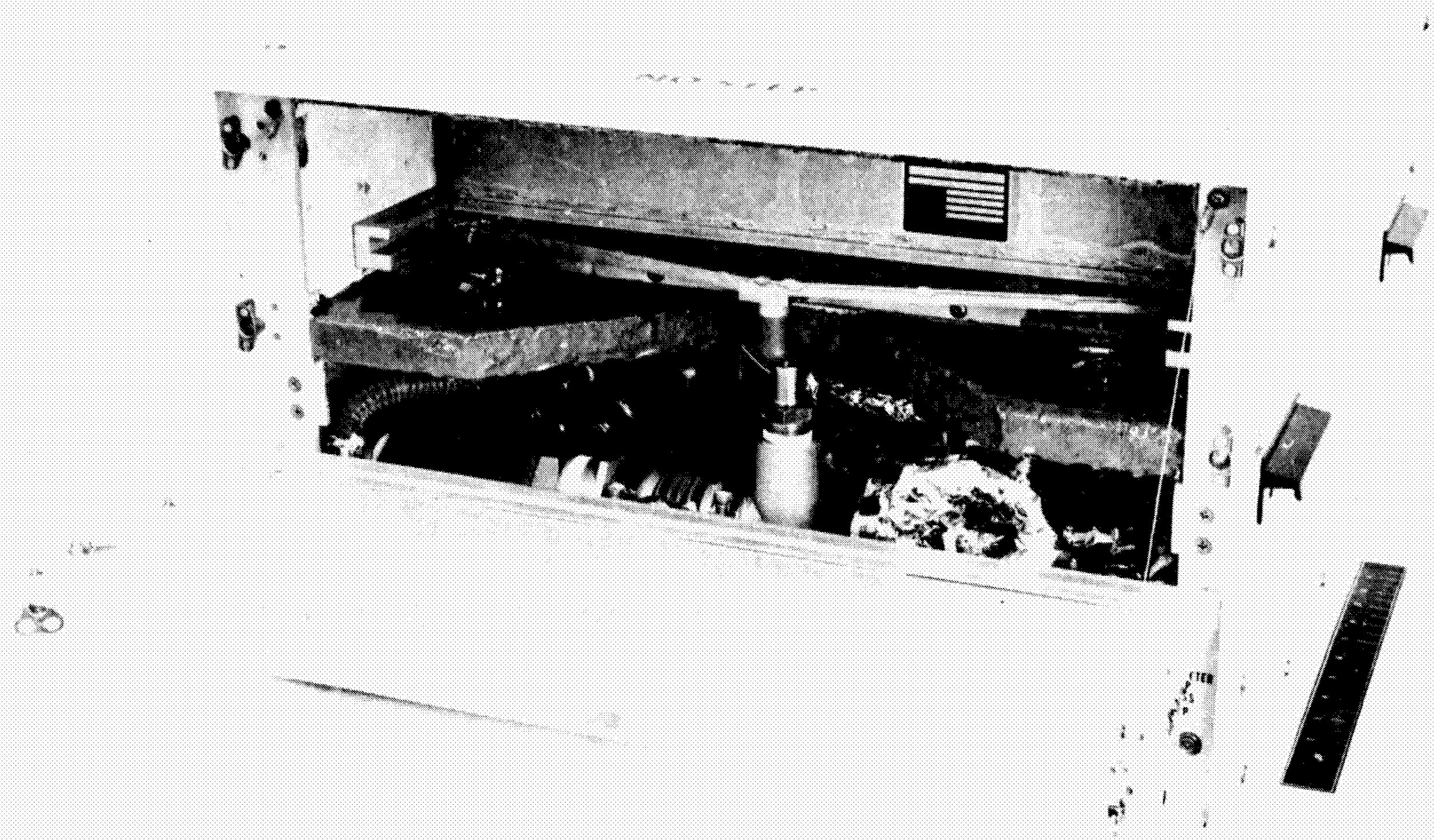
ICE PACK HEAT SINK SUBSYSTEM
LEFT SIDE VIEW

FIGURE 5



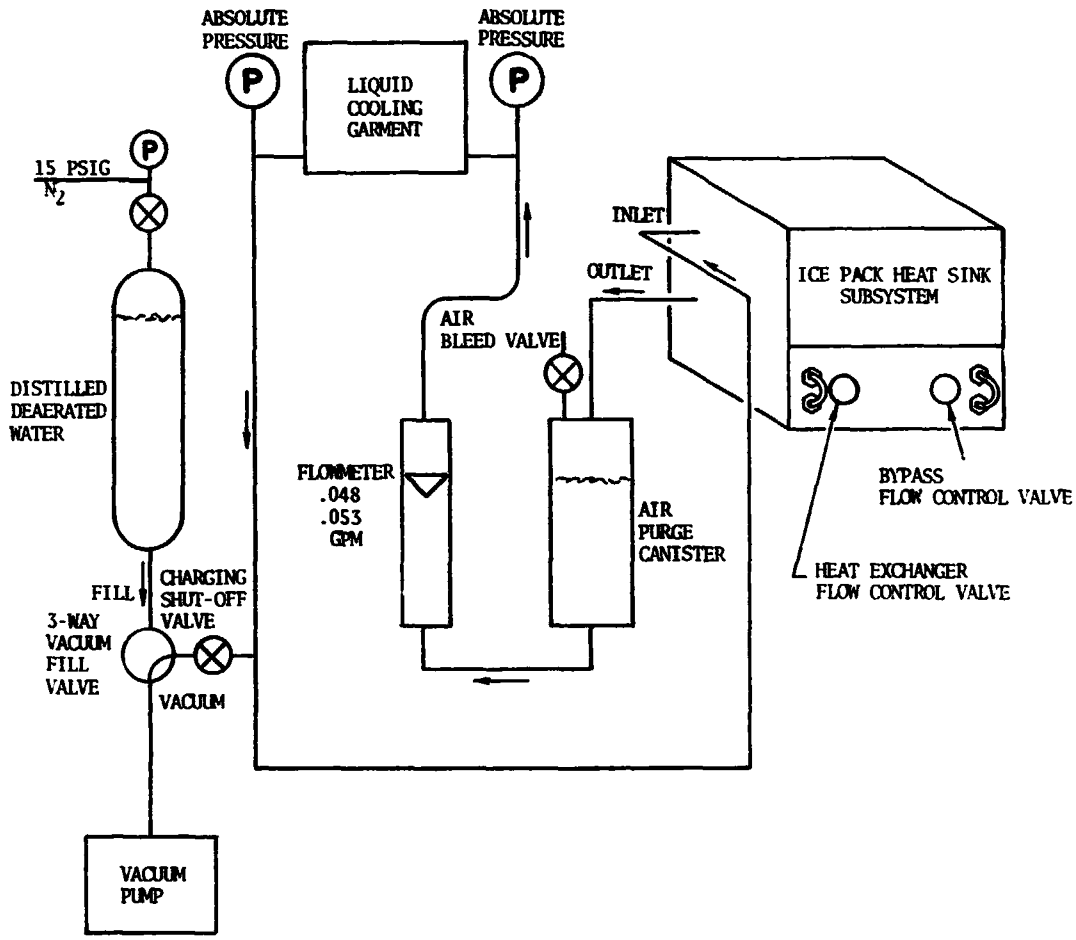
ICE PACK HEAT SINK SUBSYSTEM
REAR VIEW

FIGURE 6



ICE PACK HEAT SINK SUBSYSTEM
ICE CHEST ACCESS OPENING

FIGURE 7



ICE PACK HEAT SINK SUBSYSTEM - CHARGING DIAGRAM

FIGURE 8

STARTUP

1. Remove all protective packing material from the Ice Pack Heat Sink Consoles and Ice Chests.

2. Charge and freeze the Ice Chest per the procedure outlined in Part III, Section B, Ice Chest Charge and Maintenance.

3. Plumb the Ice Chest Heat Sink Subsystem Console as shown in figure 7 and figure 8. [It is not necessary to install a bypass flowmeter or a heat exchanger flowmeter to operate this subsystem. However, if it is desired to monitor either bypass flow or heat exchanger flow, the appropriate jumper is removed from the Console front panel and a flowmeter(s) substituted for the jumper(s)].

4. PRECAUTION: Make sure the Main Power Switch on Console is OFF. Determine if the internal power supply (battery) or an internal power supply is to be used.

   If the internal power supply is used check out the power supply per procedure outlined in Part III, Section C, Power Supply Charge and Maintenance, and attach the internal pigtail connector to the power supply.

   If an external power supply is to be used make sure the internal pigtail connector is disconnected from the internal power supply. Wire the supplied electrical connector to the external power supply set at 27 volt DC, at 3 amp, minimum, [pin A on connector is positive (+) and pin B on connector is negative (-)]. Connect the external power supply connector to the external electrical connector located on the left hand side of the Console.

5. Charge the Console per the procedure outlined in Part III, Section A, Console Charge and Maintenance.

6. Attach three male thermocouple connectors (furnished) to copper-constantan thermocouple wire and to appropriate temperature readout units. Plug the connectors into the appropriate female thermocouple connectors located on the rear panel of the Console. Refer to figure 5.

7. Open the Ice Chest access cover located on the front of the Console by rotating the four quick release fasterners 1/4 turn counterclockwise and pulling on the fasteners. Refer to figure 7. Remove the white block of insulation from the front of the Ice Chest cavity and clean the heat exchanger surface using a soft cloth and alcohol. Take care not to scratch the heat exchanger lead surface. (Refer to Part III, Section A, Ice Pack Heat Sink Subsystem Console Charge and Maintenance for procedure for repairing scratches and gouges in heat exchanger lead surface).

8. Attach a nitrogen supply line capable of supplying 8 psig and of being vented to vacuum to the bladder pressurization port located on the left hand side of the Console.

9. Set the Console front panel controls as follows:

Main Power Switch	OFF
Pump Switch	OFF
Override Closed Switch	OVERRIDE CLOSED
Override Open Switch	NEUTRAL
Heat Exchanger Flow Control Valve	CLOSED (FULL CLOCKWISE)
Bypass Flow Control Valve	OPEN (FULL COUNTERCLOCKWISE)

10. Check the appropriate power supply to ensure it is switched on and properly set per 4. above. Switch the Main Power Switch ON. Switch the Pump Switch ON. Slowly close the Bypass Flow Control Valve (clockwise) until the LCG flow as indicated on system flow flowmeter reaches 0.50 gpm. Switch the bladder pressurization line to vacuum.

11. Install the proper vapor passage outlet orifice. High heat loads use the large (blue) orifice and low heat loads use the small (gold) orifice.

12. Insert a frozen Ice Chest into the Console ice chest cavity. Refer to figure 1 and figure 7 for proper position. Make sure the Ice Chest is inserted fully into the cavity. Hook the Ice Chest vacuum exhaust fitting to the vapor passage outlet orifice using the 1 3/4" long Tygon tubing and the two tube clamps supplied. Tighten the tube clamps securely.

13. Replace the white insulation block into the front of the ice chest cavity, close the access cover, and secure the four quick release fasteners.

14. Attach a vacuum line to the Vapor Outlet Port located on the left-hand side of the Console. This line should contain a liquid trap of 1000 ml capacity, minimum, immediately at the outlet of the Console, and be capable of drawing a vacuum of 400 microns at a nominal flow of three pounds/hour.

The Ice Pack Heat Sink Subsystem now is ready for operation.

HEAT SINK OPERATION

1. Pressurize the bladder to 8 psig to make contact between the heat exchanger and Ice Chest thermal transfer surfaces. Draw a vacuum of 400 microns on the Vapor Outlet Port.

2. When heat exchanger outlet temperature becomes lower than 57°F switch the Override Closed Switch to NEUTRAL.

3. Normally, the Ice Pack Heat Sink Subsystem is run by setting the Console outlet temperature to a temperature level corresponding to a specific Btu heat rejection rate from the LCG. In any event, the Console outlet temperature is controlled as follows:

   To decrease the Console outlet temperature: - Slowly open the Heat Exchanger Flow Control Valve (ccw) and slowly close the Bypass Flow Control Valve (cw), while maintaining the system flow at 0.50 gpm. The Console outlet temperature will follow rapidly in response to the controls until the Bypass Flow Control Valve is fully closed.

   To increase the console outlet temperature: - Slowly close Heat Exchanger Flow Control Valve (cw) and slowly open Bypass Flow Control Valve (ccw) while maintaining system flow at 0.50 gpm. The Console outlet temperature will follow rapidly in response to the controls until the Heat Exchanger Flow Control Valve is fully closed.

   Note: - The heat exchanger Fixed Bypass Valve is set to prevent stagnating the heat exchanger flow; the valve thereby prevents the heat exchanger fluid from freezing.

4. When the heat exchanger outlet temperature reaches 60°F ± 3°F the Vapor Passage Shut-Off Valve will automatically open and the unit will continue to function utilizing the water boiler mode.

   Note: - If it is desired not to operate the unit in the water boiler mode, switch the Override Closed Switch to OVERRIDE CLOSED. This will prevent the Vapor Passage Shut-Off Valve from opening under any conditions.

SHUTDOWN

1. Shut off the Main Power Switch and Pump Switch. Disconnect the power supply. Switch the bladder pressurization line to vacuum. Shut off the Vapor Outlet Port vacuum.

2. Open the ice chest access door, remove the white insulation block, and disconnect the Tygon tubing between the ice chest vacuum exhaust fitting and the vapor passage outlet orifice. Remove the Ice Chest and charge it per the procedure specified in Part III, Section B.

PART III

CHARGE AND MAINTENANCE

ICE PACK HEAT SINK SUBSYSTEM - CHARGE AND MAINTENANCE

Charging Procedure

Refer to schematic figure 8 for a pictorial description of the charging apparatus. All connecting lines shown are 3/8 inch diameter x 0.035 inch wall, minimum, and may be of plastic, aluminum, or stainless steel. The line from the three-way Vacuum-Fill Valve connects to the Inlet From Liquid Cooling Garment port on the left side of the Ice Pack Heat Sink Subsystem Console and the line from the top of the deaerator connects to the Outlet To Liquid Cooling Garment port.

1. To charge the system, open Charging Shut-Off Valve, position the three-way Vacuum-Fill Valve to VACUUM, and apply 0.5 psia vacuum for a few minutes to remove air in the lines and Heat Exchanger.

2. Position three-way Vacuum-Fill Valve to FILL and allow distilled and deaerated water to be transferred into the Ice Chest under 15 psig N_2 pressure.

3. Open Heat Exchanger Flow Control and Bypass Flow Control valves fully counterclockwise. Switch Main Power and Pump switches ON and allow the water to circulate in the loop under pressure. Open Air Bleed Valve located on top of the Air Purge Canister to permit trapped air to escape, until no bubbles appear in the flowmeter for one minute.

4. Close Charging Shut-Off Valve to isolate system.

5. System has now been charged to 15 psig with the accumulator approximately maintaining this pressure relationship for all ambient pressures and system temperatures.

Maintenance

The Ice Pack Heat Sink Subsystem as designed is intended for long life service with virtually no maintenance required. In the event that the Liquid Cooling Garment Heat Exchanger's lead plated heat transfer surface becomes scratched or gouged, the following repair procedure is recommended. Remove any raised material surrounding the scratch or gouge using a curved X-acto blade or equivalent. Do not attempt to fill the depression.

PRECAUTION: Under no circumstances use abrasive paper of any kind to smooth the surface because the surface would become permanently damaged from the grit becoming imbedded in the soft coating.

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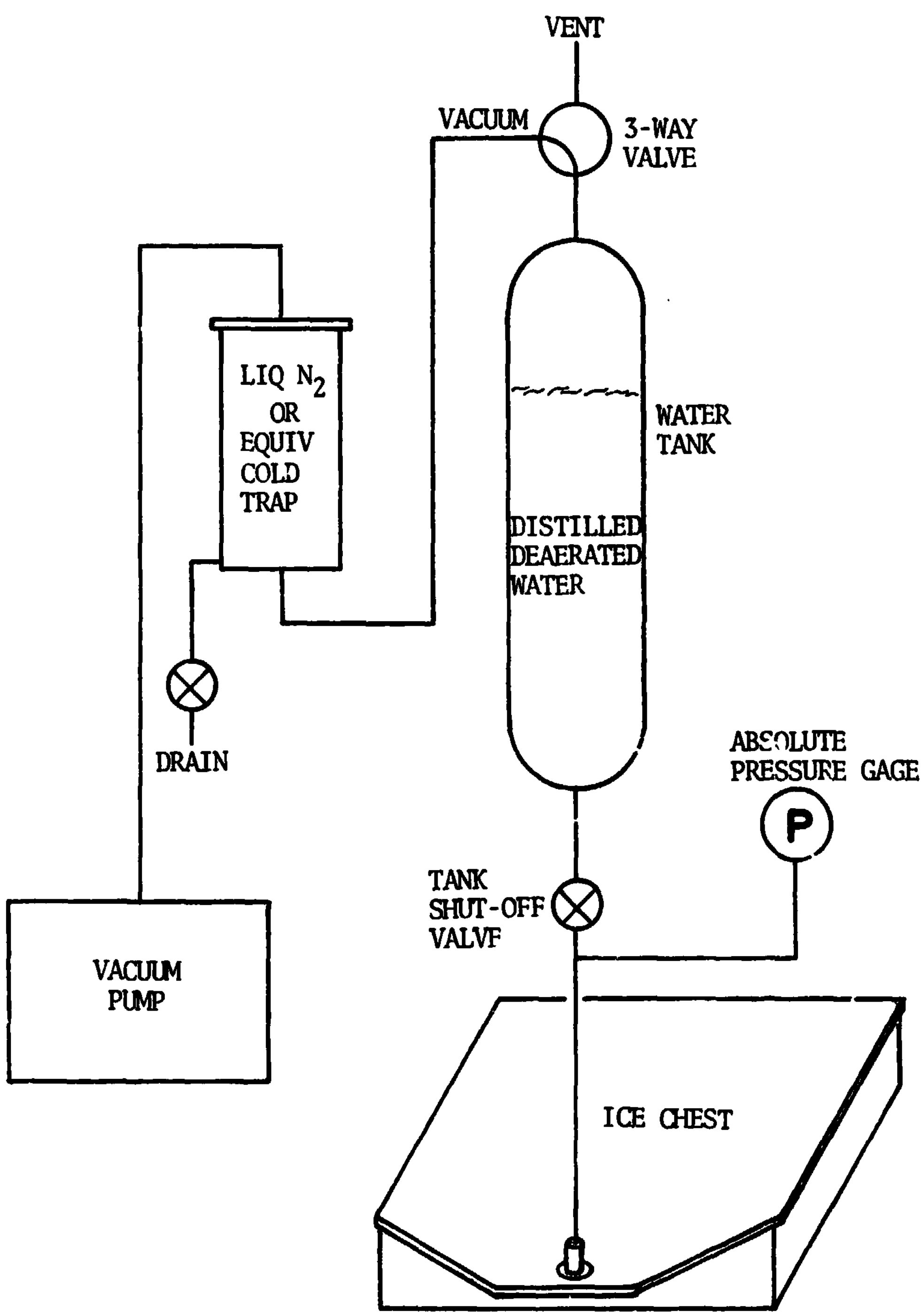


ICE CHEST EVACUATING & FILLING APPARATUS

FIGURE 9

ICE CHEST - CHARGE AND MAINTENANCE

Initial use and subsequent emergency mode use of the Ice Chest will require periodic charging, and may require occasional maintenance. The evacuation and filling apparatus recommended for the Ice Chest is shown in figure 9. The following procedure for charging a dry or partially filled Ice Chest is recommended.

1. Lay Ice Chest on a clean, sturdy surface with the vacuum exhaust fitting pointing upward. Connect this fitting to the evacuation and filling apparatus, open the tank shut-off valve, position the three-way valve to vacuum, start vacuum pump, and draw vacuum in the Ice Chest to 0.5 psia.

   If 0.5 psia vacuum cannot be achieved readily, this may indicate a leak has developed in the Ice Chest. In this event, it is recommended that the vacuum connection be removed and that a source of nitrogen or oil-free air be connected in its place. With the Ice Chest at 15 psig, the leak can be located by using Leak-Tec or an equivalent fluid. If leak appears to be in the o-ring under the cover then replace the o-ring. Make the new o-ring per SVSK 86016, note 1.

   PRECAUTION: Contact Hamilton Standard for recommended method of repair for any leak other than that of an o-ring.

   It is not required to remove the cover for normal evacuation and filling of the Ice Chest.

2. After drawing vacuum at 0.5 psia for a few minutes position three-way valve to VENT and allow the distilled, deaerated water to be siphoned into the Ice Chest until atmospheric pressure has been reached.

3. Repeat the evacuation-filling process at least one more time to insure the removal of trapped air from the wicks.

4. Remove the Ice Chest from the evacuation-fill apparatus and plug the fill port temporarily with a stopper, cap or equivalent. Turn the Ice Chest over with the fill port downward and gently place it on a clean, sturdy and smooth surface.

   PRECAUTION: PROTECT THE INTERFACE SURFACE FROM SCRATCHES.

5. Remove the plug from the fill port and allow it to drain until the drain rate is reduced to 1-2 drops per second.

6. Invert the Ice Chest so that the vacuum exhaust fitting faces upward and then weigh the Ice Chest. The net weight increase must be at least 7 kg (15.4 lbs.) over the dry weight marked on the exhaust passage cover. If the weight increase is less, this indicates incomplete saturation and Steps 1 and 2 must be repeated at least one more time.

7. After satisfactory saturation has been obtained, place the Ice Chest with its vacuum exhaust fitting facing upward in a 0°F freezer for approximately 12 hours, taking care that moisture on the thermal interface surface is kept to a minimum.

In case of damage to the thermal interface surface such as scratches, gouges, etc., the following repair procedure is recommended. Locally remove any raised material surrounding the indentation. Do not attempt to fill in the depressed area since the design of the interface surface is based on only an average contact area. Then smooth the damaged area with fine cloth and then touch up with Alodine 1200.

No other maintenance procedures are required during usage of the Ice Chest.

POWER SUPPLY - CHARGE AND MAINTENANCE

SVSK 86112

The Power Supply as received by NASA with the Ice Pack Heat Sink Subsystem is fully charged and ready for operation. The Power Supply has the following characteristics:

Nominal Capacity	-	20 ampere-hours
Operating Voltage	-	33.5 to 19.8 volts

After the initial discharge to 19.8 volts, it is necessary to remove the Power Supply following the procedure described below, and to further discharge each individual cell to a 1.0-volt potential at a rate of 2.0 amperes prior to subsequent recharge. Thereafter, prior to every tenth charge cycle, remove and disassemble the Power Supply according to the following procedure and further discharge each individual cell to a 1.0-volt potential at the rate of 2 amperes, prior to recharging. Charging the Power Supply at times other than those described above can be accomplished through the external connector without disassembly of the Power Supply.

Procedure for Initial Charge and Every Tenth Subsequent Recharge

Disassembly Procedure

1. Power Supply Switch must be in OFF and there must be no connection to the External Connector.

2. Remove the two right side handles, SVSK 86183, held in place by two MS34693-275 countersunk head screws each, then remove the right side panel SVSK 86144 and rear panel SVSK 86143 from the Ice Pack Heat Sink Subsystem.

3. Disconnect inside electrical connector located on the forward surface of Power Supply.

4. Position Ice Pack Heat Sink Subsystem unit to obtain access to the four MS34693-275 countersunk head screws holding the Power Supply in place. Remove the four MS21043-3 nuts and AN960C10 washers and slide the Power Supply through the rear panel opening of the Ice Pack Heat Sink Subsystem.

5. To open Power Supply, remove the fourteen NAS 1100E3-12 screws using a Torque Set Apex 8 or equivalent driver. Remove the Cover, SVSK 86112-101, and take out the styrofoam spacer.

   WARNING: THE POWER SUPPLY IS CAPABLE OF SUPPLYING UNUSUALLY HIGH CURRENT. PROLONGED SHORT-CIRCUIT MAY DESTROY THE CELLS. THEREFORE, ALL TOOLS USED IN SERVICING THE POWER SUPPLY SHOULD BE PROPERLY INSULATED WITH ELECTRICAL TAPE OR VARNISH.

6. Proper electrolyte level normally remains in the batteries throughout the life of the Power Supply and no electrolyte or distilled water should be added. Under no circumstances should the electrolyte level be permitted to exceed the height of the plates.

   WARNING: THE ELECTROLYTE (A STRONG SOLUTION OF POTASSIUM HYDROXIDE) IS ALKALINE AND CORROSIVE. IT MUST BE HANDLED WITH CARE. THE ELECTROLYTE WILL CAUSE SERIOUS BURNS IF IT IS PERMITTED TO COME IN CONTACT WITH THE EYES OR SKIN. ALKALI-PROOF APRON, RUBBER GLOVES AND SPLASH-PROOF GOGGLES OR A FACE MASK ARE RECOMMENDED FOR PERSONNEL ENGAGED IN THE FILLING OF THESE BATTERIES. REFER TO THE YARDNEY ELECTRIC DIVISION BULLETIN IN THIS SECTION FOR FURTHER DETAIL ON PRECAUTIONS AND FIRST-AID TREATMENT.

If the cell tops and terminals are corroded with electrolyte they can be effectively cleaned with a 4 percent solution of glacial acetic acid.

Tighten all battery terminals to a torque of 35 - 40 in-lb and proceed with the voltage drain procedure for each cell as described previously. Do not charge the Power Supply at this point but proceed to reassemble the unit according to the steps that follow.

Reassembly Procedure

1. Brush away or blow out any debris in and around the o-ring groove and on the o-ring. Visually inspect the o-ring and in the event it is damaged, refer to note 4 of drawing SVSK 86112, Power Supply, for repair or replacement.

2. Replace the styrofoam spacer on the batteries and bolt the Cover SVSK 36112-101 with the fourteen each of the NAS 1100E3-12 screws, the AN960C10 washers and the MS21043-3 nuts. Torque each screw to 35 - 40 in-lb.

3. Replace the Power Supply in the Ice Pack Heat Sink Subsystem with its connector facing the front of the unit, position the Power Supply over the mounting holes and insert the four MS34693-275 countersunk head screws. Install the four AN960C10 washers, four MS21043-3 nuts and tighten the assembly.

4. Connect the internal pigtail connector to the Power Supply and replace panels SVSK 86144 and SVSK 86143 on Ice Pack Heat Sink Subsystem. Reinstall the two handles SVSK 86183 using four MS 34693-275 screws.

5. The unit is now ready for the charging operation.

Charging Procedure

The Power Supply should be at a temperature of 60°F to 80°F before charging. The Modified Constant Potential Method is recommended for charging the Power Supply with a current limited charging rate (encountered at the start of the charge cycle) of 1.0 ampere maximum and a charging voltage of 33.0 to 33.5 volts. A fully charged Power Supply should have an open voltage in the range of 32.7 to 33.5 volts. Continued charging after the 33.5 volts level has been reached will cause excessive heating and gassing of the cells with subsequent damage to the Power Supply. At no time should the Power Supply charging voltage be allowed to exceed 36 volts during any charge.

Critical Temperatures

Temperature as low as -55°F will not permanently damage the batteries in the Power Supply and warming the Power Supply will restore its capacity. However, temperatures above 185°F (85°C) will soften the plastic case of the batteries. Do not store the Power Supply for prolonged periods at temperatures higher than 110°F.

Yardney Electric Division Bulletin

For further information on the batteries, the Yardney Electric Division "Bulletin: 1000 Series Service and Operating Instructions for the Yardney Silvercel® Battery" has been included in this section.

portant: These instructions are for individual cells only. If cells are to be assembled into a battery pack contact the manufacturer for proper instructions, indicating the number of cells, voltage, capacity rating and discharge currents of the pack.

BULLETIN: 1000 SERIES

SERVICE AND OPERATING INSTRUCTIONS FOR THE YARDNEY SILVERCEL® BATTERY

MODEL: LR200C-3

CONDITION: Dry Charged

EFFECTIVE DATE: January, 1971

NOTE: Unless otherwise indicated, these instructions shall supersede earlier dated information.

YARDNEY ELECTRIC DIVISION

Pioneers in Compact Power®

82 MECHANIC STREET, PAWCATUCK, CONN. 02891

GENERAL INFORMATION CONCERNING THE Yardney *SILVERCEL®* BATTERY

1. Introduction

Here is your Yardney Compact Power battery designed to meet your exact requirements. It is efficient and reliable. Rugged, yet light in weight. Powerful, yet sensitive.

Before proceeding to service and operate your battery, read this entire manual in order to learn how to maintain it properly for maximum life and performance

2. Description

The YARDNEY SILVERCEL is a silver-zinc alkaline battery which differs considerably from the more familiar lead-acid battery, and to a certain extent from other alkaline batteries such as nickel-cadmium, nickel-iron, etc. Silver and zinc are employed as the electrodes. The electrolyte is a strong solution of potassium hydroxide (KOH). The techniques for servicing the YARDNEY SILVERCEL are quite simple and should be followed closely.

3. Available Cell Types

The YARDNEY ELECTRIC CORPORATION manufactures three series of SILVERCEL batteries:

(a) HR (Hi Rate Discharge) series – for applications requiring the total energy of a cell to be expended in one hour or less. The life expectancy of HR batteries is approximately 10 to 20 charge-discharge cycles or a period averaging 6 months wet life, whichever comes first.

(b) LR (Low Rate Discharge) series – for applications requiring the total energy of a cell to be expended over a period of time greater than one hour. The life expectancy of LR batteries is approximately 60 to 100 charge-discharge cycles or a period averaging 9 to 12 months wet life, whichever comes first.

(c) PM Series (manually activated primary batteries) – for applications requiring quick activation and high-rate discharges. The life expectancy of PM SILVERCEL batteries is approximately either 3 to 5 cycles or a period of 2 months wet life, whichever comes first.

4. Expansion Characteristic

(a) Subsequent to filling and formation cycling, the YARDNEY SILVERCEL may evidence a slight swelling perpendicular to the electrode face. The swelling is in no way detrimental to the performance of the SILVERCEL.

(b) Individual SILVERCEL drawings which show, dimensionally, the expansion property are available upon request.

(c) Overall dimensional stability can be maintained if the battery container is designed using the proper material for restraint or proper dimensions to accommodate swelling.

(d) If SILVERCEL units are to be assembled in a battery container, we recommend that this be accomplished upon receipt of cells prior to servicing.

5. Short Circuits

The YARDNEY SILVERCEL battery is capable of supplying unusually high current. However, a prolonged short-circuit may destroy the battery. To avoid short-circuits all tools used in servicing should be properly insulated with electrical tape or varnish.

6. **Critical Temperatures**

Low temperatures (as low as -55^{o}F.) will not permanently damage the SILVERCEL, and warming it will restore its capacity. High temperatures are definitely harmful. The plastic case begins to soften at 185^{o}F. (85^{o}C.). Do not store the SILVERCEL for prolonged periods at temperatures higher than 110^{o}F.

7. **Peroxide Portion of Discharge Curve**

A characteristic of the SILVERCEL, predominantly when discharged at the one hour rate or lower, is the "peroxide" portion of the discharge curve. This characteristic occurs at the beginning of a discharge and is evidenced by a high initial voltage which gradually decreases to a steady value and is present for approximately 15-25 per cent of the normal discharge curve. The elimination of this sloping voltage, if undesirable, can be accomplished by pre-discharging the SILVERCEL at approximately two and one-half times the one hour rate for a minute or two. The higher the discharge rate the less noticeable is the "peroxide" characteristic.

8. **Gas Evolution**

The YARDNEY SILVERCEL is relatively free from the hydrogen explosion hazard which is common to conventional types of batteries when used in closed, non-ventilated areas. However, sufficient hydrogen to cause an explosion (if ignited) may be generated should the SILVERCEL become defective or is badly overcharged.

No special battery room is required for servicing Yardney SILVERCEL batteries. Just allow for adequate work space, light and ventilation.

9. **Terminology**

1. Battery – The term "battery" is used to refer to both battery and cell. Occasionally "cell" is used to differentiate between the basic unit and the battery.

2. Nominal Capacity – The term nominal capacity refers to the capacity classification of the battery. For most batteries, nominal capacity closely approximates working capacity toward the end of battery life.

3. Cycle – The term cycle includes both a charge and discharge.

4. Charging end voltage – The charging end voltage indicates the charging voltage not to be exceeded while the battery is on charge.

5. Plateau – The term plateau applies to the flat portion of the discharge curve and is used to indicate the steady voltage prevalent during most of the discharge.

Yardney *SILVERCEL* ELECTROLYTE

PRECAUTIONS FOR HANDLING FILLED BATTERIES

Ordinarily, no trace of the alkaline electrolyte (potassium hydroxide) appears on the outside of the case of filled batteries. However, personnel who work with the batteries should wash their hands thoroughly after handling them.

If potassium hydroxide is accidentally spilled it can be readily neutralized and washed away. Read the instructions below for proper handling of the electrolyte.

Personnel who fill the batteries or otherwise handle the electrolyte should read the precautions outlined below to assure maximum safety and prevent injury which may result from accidental spillage of electrolyte.

PRECAUTIONS FOR HANDLING ELECTROLYTE

1. **General Comments:**

   The electrolyte (a strong solution of potassium hydroxide) is alkaline and corrosive. It should be handled with care. If neglected, the electrolyte will cause serious burns when it is permitted to come in contact with the eyes or skin. Alkali-proof apron, rubber gloves and splash-proof goggles or a face mask are recommended for personnel engaged in the filling of SILVERCEL batteries.

2. **Antidotes, Internal:**

   Give large quantities of water and a weak acid solution such as: vinegar, lemon juice, or orange juice. Follow with one of the following: white-of-egg, olive oil, starch water, mineral oil, or melted butter. Obtain medical attention at once.

3. **Antidotes, External:**

   (a) For the skin: wash the affected area with large quantities of water. Neutralize with vinegar, lemon juice, or 5% acetic acid, and wash with water. Obtain medical attention at once.

   (b) For the eyes: flush thoroughly with water. Follow with saturated solution of boric acid. Use this first-aid treatment until medical aid can be summoned.

4. **Washing Glassware:**

   The electrolyte is somewhat corrosive to glass. All beakers and syringes should be thoroughly washed with water following their use.

5. **Carbon Dioxide Absorption:**

   Store the electrolyte in closed alkali resistant containers as it absorbs carbon dioxide from the air. Prolonged exposure to the air will impair the properties of the electrolyte.

6. **Caution:**

   Do not, under any circumstance, attempt to use any type of electrolyte other than the special electrolyte furnished with the YARDNEY SILVERCEL. Other types of electrolyte will destroy it.

   For best soaking results, the temperature of the electrolyte at the time of filling should be maintained at 70°F - 80°F.

FILLING AND FORMATION PROCEDURE FOR *Yardney* SILVERCEL BATTERIES

1. The Yardney SILVERCEL batteries are shipped with sufficient electrolyte in separate containers to activate them, and with a filling kit containing the following items:

   NOTE: Batteries not to be used within 30 days of receipt, should be stored in dry condition.

Item	Quantity	Description
1	11	4 oz. polyethylene bottles (with caps), each containing sufficient amount of electrolyte to activate one cell of the battery.
2	1	Extra vent caps
3	11	Extra sponge rubber plugs
4	11	Vent cleaners
5	1 pair	Tweezers
6	¼ oz.	Absorbent cotton
7	1	Polyethylene filling caps

2. To properly fill each cell, proceed as follows:

   (a) Remove the plastic vent cap from each cell. With tweezers, remove the sponge rubber plug from the vent hole. Keep both the vent cap and the sponge rubber plug.

   (b) Remove the plastic cap from an electrolyte bottle containing the proper amount of electrolyte for one cell. Puncture the polyethylene seal with the tweezers (provided in the filling kit) or other sharp object.

   (c) Screw one of the polyethylene filling caps, provided in the filling kit, securely onto the electrolyte bottle.

   (d) Insert the filling cap tip into the cell vent hole, twisting clockwise to insure a tight fit.

   (e) Squeeze the electrolyte bottle gently, maintaining the pressure for a few seconds to avoid drawing back electrolyte into the bottle. Repeat this operation slowly until *all* of the electrolyte has been transferred into the cell. If the electrolyte is repeatedly drawn back into the bottle, wait for a few minutes until the level in the cell decreases, then introduce the remaining electrolyte into the cell.

   (f) After filling is completed, remove any excess electrolyte from the vent hole by using the vent cleaner. Insert a vent cleaner up to the knot, into the cell vent hole and turn for one complete revolution. Use new vent cleaner for each cell.

   (g) Remove any excess electrolyte from around the outside of the vent holes with a piece of cotton, using tweezers.

   (h) Replace the sponge rubber plug into the cell vent hole after the removal of excess electrolyte is completed. *It is recommended that the sponge rubber plug be positioned in the cell vent immediately after the filling of each cell in order to minimize any possibility of filling one cell twice or not filling a cell at all.*

   (i) After the filling operation of one cell has been completed, the polyethylene filling cap should be removed from the bottle, the filling bottle discarded and the filling cap should be put on a new electrolyte bottle.

   (j) After filling all cells in the same manner as described above and having replaced the sponge rubber plugs, allow the battery to soak for the prescribed period (Item 4, 1009). During the soaking period the battery should be tilted approximately 30 degrees from the vertical in the plane parallel to the battery plates. Secure the battery in this position and allow the battery to soak for half of the prescribed soaking time. Tilt the battery on its opposite side for the remainder of the soaking period.

   NOTE: The cell vent caps should not be replaced until battery formation (Sec. 3 and 4) is completed.

3. **Activation of the Dry Charged Battery**

(a) After the addition of electrolyte and the elapse of the prescribed soaking time (page 1009, item 4) the battery is ready for use. No formation cycling is necessary with the dry charged battery.

(b) Before using the battery, open circuit voltages should be checked on each cell. This voltage should be approximately 1.82 - 1.86 volts per cell immediately following the prescribed soaking time. However, the open circuit voltage may not remain completely stable for a period of 48 hours immediately following the prescribed soaking period.

NOTE: The open circuit voltage of PM type Silvercels may be anywhere in the range of 1.60 – 1.86 volts after initial filling. This is because the positive plates are processed to remove the "Peroxide Voltage" on initial discharge (in many models). However, after the first recharge, the open circuit voltage should be in the range of 1.82 – 1.86 volts/cell.

4. **Initial Discharge and Drain**

Following its initial discharge, drain the battery further at the 10 hour discharge rate (nominal rated capacity divided by 10) until the battery voltage drops to 1.0 volts per cell (for batteries – 1.0 volts x number of cells).

NOTE: This drain is necessary after the initial discharge and after every five or six application discharges to assure maximum life for the battery. To recharge, see "OPERATIONAL PROCEDURES", page 1006.

5. **Storage of Dry Charged Battery**

(a) **Storage prior to filling:**

If it is anticipated that the battery will not be used for a prolonged period of time following its receipt it should be stored in the dry state for optimum results. When it is desired to use the battery it can be filled as described in "FILLING & FORMATION PROCEDURE", page 1004, soaked the proper amount of time and used.

(b) **Storage Subsequent to filling:**

If it is desired to store the battery for thirty days or longer at some time after the battery has been filled it should be stored in the discharged condition following the storage instructions as outlined in "MAINTENANCE" section, page 1007, paragraph 3.

6. **Use Subsequent to Activation**

If the battery is to be used within thirty days following activation, follow the instructions as outlined in "OPERATIONAL PROCEDURES", page 1006.

1. Battery Rating

The nominal capacity of this battery is given on page 1009, item 1; and the nominal voltage is given in item 2.

2. Intercell Connection

Periodically and before a high rate discharge is performed, a check on the tightness of the cells top terminal nuts is recommended to assure maximum intercell conductivity. Tighten the top terminal nuts to the correct torque (item 16.) Bottom nuts located at the base of the terminal post are preset and should *not* be tightened or loosened.

3. Subsequent Charging

Charging can be accomplished by either the modified constant potential or the constant current method. While the constant current method provides the fastest means of achieving a normal input, the modified constant potential method requires much less personal attention and can be obtained automatically by considerably less complex equipment.

ALL AUTOMATIC YARDNEY SILVERCEL CHARGERS ARE DESIGNED TO CHARGE BY THE MODIFIED CONSTANT POTENTIAL METHOD (Tapered charging). These instructions give values for both modified constant potential and constant current charges.

Initiate charging the battery at the rate specified (item 11a or 11b) until the battery voltage reaches the end charging voltage, (Item 12) while charging. For constant current charging, maintain the rate throughout the charge. For modified constant potential charging no further current adjustment is necessary during the charge.

4. Charging Temperature

A battery should be a temperature of 60°F to 80°F before charging.

5. Charging Precautions

(a) The battery voltage during any charge should never be allowed to exceed the end voltage (item 12) while charging. An adequate ampere-hour input is normally obtained at this point. If charging is not stopped, the voltage rises rapidly and may cause excessive heating and gassing, detrimentally affecting the battery.

(b) Charging shall be interrupted for 8 to 16 hours, if at any time during the charge, electrolyte is forced out of the cell vent, or the intercell connectors or terminals become too warm to touch (140°F to 150°F).

NOTE: Be sure the hole in the vent cap (or valve) is clear.

6. Discharge Rates

(a) HR and PM (High Rate Discharge) Batteries:

1. HR batteries are designed for unusually high discharge rates. For optimum battery operation and maximum battery life we recommend that the time limit specified for continuous discharge in items 13 (HR), 14 and 15 be observed.

2. If it should be desired to discharge the battery at a higher rate than the maximum recommended rate, or for a longer time, care should be taken not to allow the battery to heat itself during the discharge beyond 165°F. (temperature measured on either cell terminal by using a thermocouple) if reliability of recyclability is desired. After the discharge is concluded, the cell's plastic container will continue to heat because of the thermal lag.

(b) LR (Low Rate Discharge) Batteries:

If maximum capacity and recyclability are desired, LR batteries should be discharged at a rate not to exceed that shown in item 13 (LR) (Page 1009).

MAINTENANCE OF THE *Yardney* SILVERCEL

1. General

A minimum of maintenance is required to keep the SILVERCEL in optimum operating condition. Cell tops and terminals should be kept clean and dry (any corrosion due to atmospheric conditions should be emoved immediately). Also, an occasional inspection of the vent hole and vent cap and sponge rubber plug (or valve) should be made to assure that they are not clogged.

2. Battery Serviceability Check

Whenever circumstances permit, an open circuit voltage check (no load being applied to the battery) should be made 24 hours after the battery has been fully charged. If the open circuit cell voltage is observed to be less than 1.82 volts during this inspection, check the following items:

(a) Check voltmeter accuracy with a known reference voltage.

(b) Observe the top surface of the battery to see it it is deformed from overheating or is gassing excessively. If this is the case, the battery should be considered defective and removed from service.

(c) If the battery does not appear to be defective, charge it according to "OPERATIONAL PROCEDURE" (Page 1006) and again check the open-circuit voltage after an additional 24 hour stand period. A cell should be considered unserviceable if the voltage again reads below 1.82 volts.

3. Storage Conditions

(a) **Dry Batteries:**

It is recommended that batteries shipped in the dry condition which will not be placed in service for 30 days or more, should be stored in the dry condition at a temperature not to exceed 150°F.

Dry, uncharged batteries may be stored for several years.

Dry, charged batteries may be stored for periods up to one year, depending upon the temperature at which they are stored.

(b) **Wet Batteries:**

If it is desired to store the battery for 30 days or longer, it should be discharged at the 10-hour discharge rate (nominal capacity divided by 10) to 1.0 volt per cell (for batteries – 1.0 volt x number of cells). Then tape all cell vent caps (or valves) with cellophane tape and apply a thick coating of vaseline, or equal, to the entire surface of cells including terminals and taped areas.

The battery may be stored safely at temperatures between 0°F to 110°F. However, the lower temperature ranges (0° to 90° F.) are more satisfactory for storage with the optimum temperature for long term storage being 32°F.

NOTE: It is important that the battery not be stored in an atmosphere heavy in carbon dioxide gas.

4. Booster Charge

To insure optimum performance, after an extended charged stand period, the battery should be given a freshening charge before it is used. Charge at the recommended rate (item 11a or 11b, page 1009) until the battery voltage reaches the prescribed value (item 12) while charging. (The freshening charge should take approximately one hour or less).

5. **Occasional Drain**

To assure the maximum number of cycles for the life of the battery, drain-discharge it every 5 or 6 application discharges. This drain can be accomplished at the 10-hour discharge rate (nominal rated capacity divided by 10) until the voltage drops to 1.0 volt per cell (for batteries – 1.0 volt x number of cells). To recharge, see "OPERATIONAL PROCEDURES," page 1006.

6. **Correct Electrolyte Level**

The electrolyte level should never be permitted to exceed the height of the plates, except during the initial filling of each cell. The battery contains sufficient electrolyte and no additional electrolyte or distilled water should normally be added through-out the life of the battery. However, if the battery, when fully charged *and inspected immediately after charge,* shows no electrolyte, *sufficient electrolyte of the same type as used to fill the cells* should be added by means of a hypodermic syringe or filling bottle until the level reaches one half (1/2) of the plate height. When adding electrolyte, allow sufficient time to elapse (15 to 20 minutes) so that the electrolyte level has an opportunity to equalize itself. Care should be taken not to puncture or cut the separator material located below the cell vent trap.

NOTE: Where cell cases are not transparent do not attempt to adjust electrolyte level under any conditions.

7. **Recommended Cleaning Solutions**

Cell tops and terminals can be effectively cleaned with a 4% solution of glacial acetic acid.

SERVICE AND OPERATING DATA FOR THE YARDNEY SILVERCEL®

CELL MODEL NO. LR20DC-3

ITEM	DESCRIPTION		UNITS
	Nominal Characteristics		
1	Capacity	20	AH
2	Voltage	1.5	Volts
	Filling and Soaking		
3	Electrolyte Quantity	64	cc
4	Minimum Soaking Time	72	Hrs
	Formation Charge(s)		
5a	Charging Rate (Method "a" Constant Current)		Amps
5b	Initial Charging Rate (Method "b" Modified Constant Potential)		Amps
6	Charging End Voltage		Volts
	Formation Discharge(s)		
7	Discharge Rate		Amps
8	End Voltage		Volts
9	Minimum Discharge Time		Mins.
10	Minimum Output		AH
	Subsequent Charges		
11a	Charging Rate (Method "a" Constant Current)	0.8	Amps
11b	Initial Charging Rate (Method "b" Modified Constant Potential)	1.5	Amps
12	Charging End Voltage	2.0	Volts
	Service Discharges		
	A. HR (high rate) Series Time limits at various discharge rates		

Item	Discharge Rate (Amps)	Time Limit (Minutes)
13		60
14	N	20
15	A	10
15		5

ITEM	DESCRIPTION		UNITS
	B. LR (low rate) Series		
13	Maximum Discharge Rate	20	Amps
	End Voltage	1.1	Volts
	Battery Assembly Data		
16	Torque (Top Terminal Nuts)	35-40	In Lb

IMPORTANT: See notes on other side

EXPLANATORY NOTE TO GENERAL DATA FOR STANDARD YARDNEY SILVERCEL® BATTERIES

ITEM	TITLE	UNITS	DESCRIPTION
1	Nominal Capacity	AH	Indicates capacity class of the cell. For most cell models working cell capacity toward the end of cell life closely approximates nominal capacity.
2	Nominal Voltage	Volts	Indicates voltage class of the cell. For most cell models, nominal voltage closely approximates closed-circuit voltage at the 1 hour-rate.
3	Electrolyte Quantity	CC	Indicates the amount of electrolyte to be used in filling.
4	Minimum Soaking Time	Hrs.	Indicates minimum length of time the cell should be allowed to soak between filling and formation.
5a	Charging Rate	Amps	Indicates charging current for cell formation, using constant current charging method.
5b	Initial Charging Rate	Amps	Indicates initial charging current for cell formation not to be exceeded, using modified constant potential charging method.
6	Charging End Voltage	Volts	Indicates charging voltage not to be exceeded while cell is on charge.
7	Discharge Rate	Amps	Indicates discharge rate to be used during cell formation period.
8	End Voltage	Volts	Indicates closed circuit voltage at which formation discharge should be stopped.
9	Minimum Discharge Time	Mins.	Indicates minimum length of time the cell should be capable of sustaining the discharge before its voltage drops to 1.1 volt when discharged at the rate, item 7, in order to be regarded fully formed.
10	Minimum Output	AH	Indicates the AH output corresponding to item 9.
11a	Charging Rate	Amps	Indicates charging current in subsequent service, using constant current charging method.
11b	Initial Charging Rate	Amps	Indicates initial charging current in subsequent service, using modified constant potential charging method.
12	Charging End Voltage	Volts	Indicates charging voltage not to be exceeded while cell is on charge.
13 thru 15	Service Discharges		Indicates, for continuous (non-intermittent) discharges at various currents, the length of discharge time not to be exceeded for safe operation and maximum cell life.
16	Battery Assembly Data	In-Lb.	Indicates the torque not to be exceeded in tightening cell terminal top nuts when assembling individual cells to form a battery pack.

NOTES: 1. All data shown apply to individual cells only (not battery packs).
2. All data are applicable to initial cell temperatures in the range of 60–90° F. only.

YARDNEY ELECTRIC CORP.

Patents granted and pending.

PART IV

MECHANICAL AND ELECTRICAL COMPONENT SPECIFICATIONS

This Part IV contains five sections:

Section A	Ice Chest
Section B	Coolant Loop
Section C	Pressurization Bladder
Section D	Vacuum Loop
Section E	Electrical Loop

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION

PART IV

SECTION A

ICE CHEST

Hamilton Standard

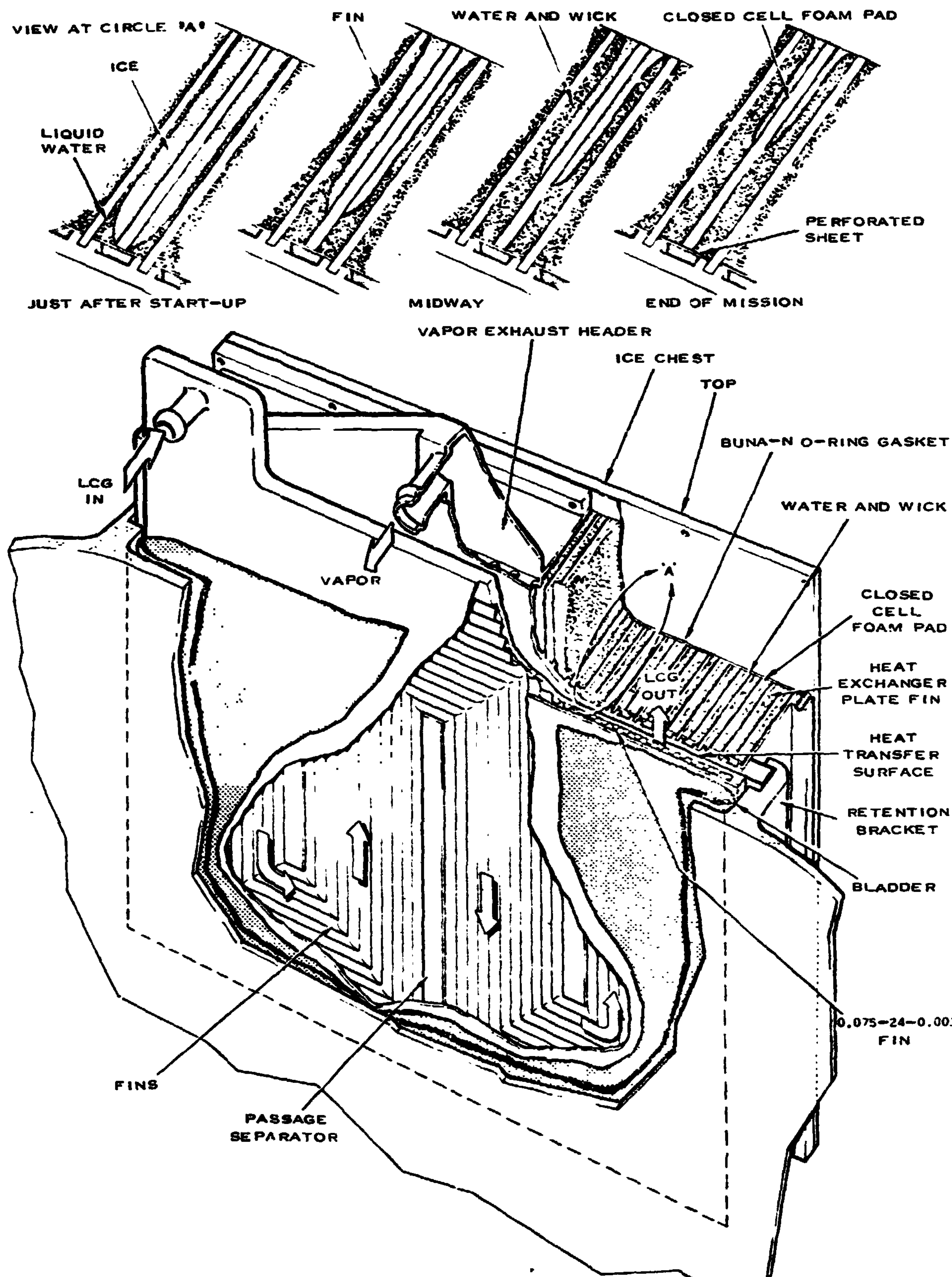


FIGURE 2-13. ICE CHEST/HEAT EXCHANGER – NORMAL OPERATING MODE

FIGURE 10

ICE CHEST

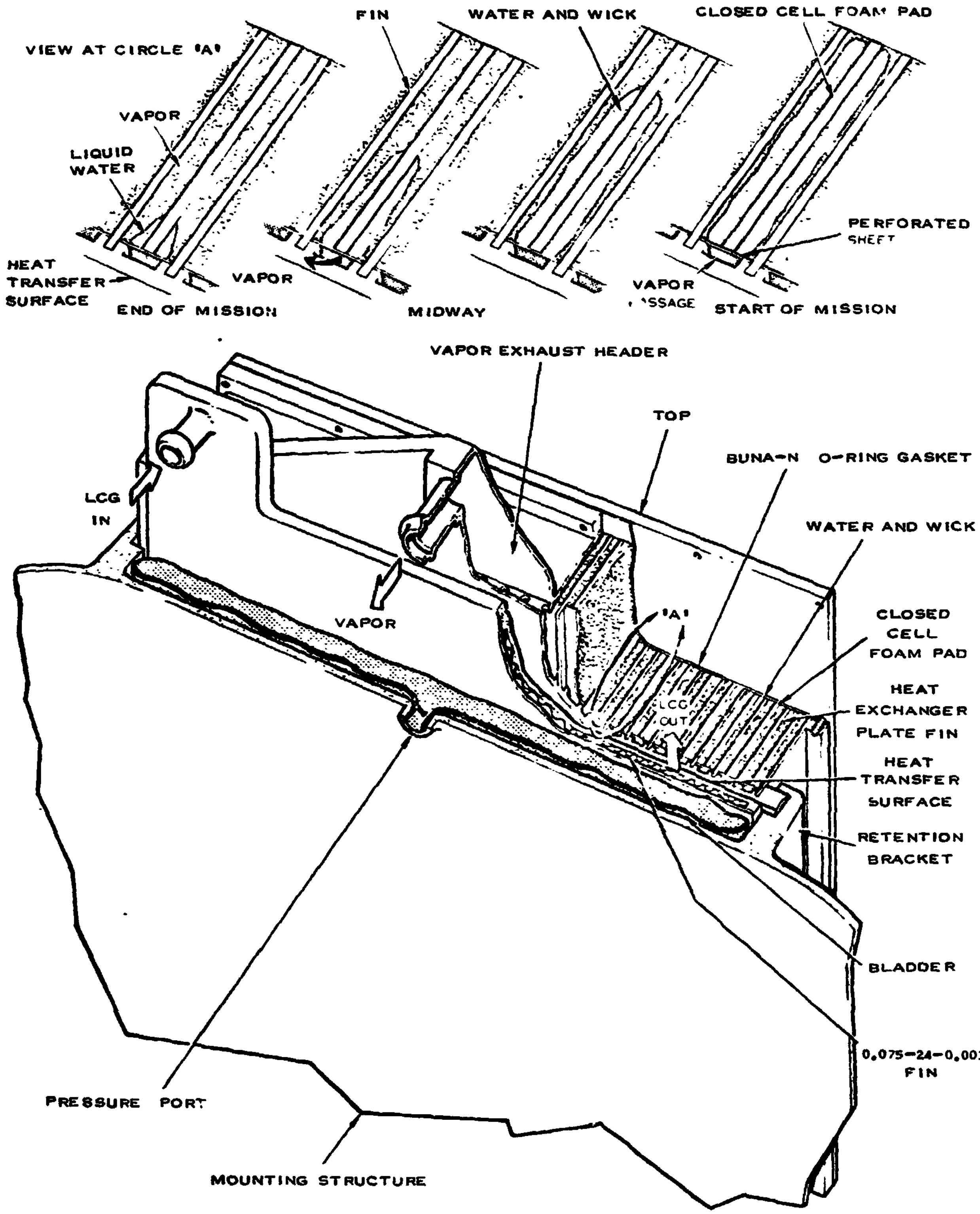
SVSK 86016

The Ice Chest is a Hamilton Standard designed item. It is intended to act as the heat sink for heat generated in the liquid cooled garment (external to the Ice Pack Heat Sink Subsystem) and transferred to the Ice Chest by the LCG heat exchanger, both in the normal (melting) mode and the emergency (boiling) mode. As designed, the Ice Chest consists of a housing, a top, a buna-N o-ring gasket, dacron felt wicks, and closed cell foam expansion compensation pads sandwiched by aluminum plates. Refer to figures 10, 11, 12, and 13. The housing is constructed predominantly of sheet metal wherein the sides and fins are spaced on a pitch of 0.6 inch. The fins run the full depth of the Ice Chest and from top to bottom. The bottom of the ice Chest is constructed of aluminum plate stock machined with grooves in which the fins are placed and additional grooves which act as the vacuum passage during emergency operation. These grooves run the full depth of the Ice Chest between the fins and run into the vapor exhaust header. On top of the vacuum grooves, and in between the fins, is a perforated sheet. This perforated sheet acts as the boiling heat transfer surface during emergency operation. The entire sheet metal assembly described above is fluxless brazed to form a structural unit. After brazing, the underside of the bottom of the Ice Chest is finish machined to ensure flatness.

The spacing between each fin is 0.50 inch. Inserted in this cavity are two layers of 0.20 inch thick wicking material separated by a layer of 0.10 inch thick closed cell foam and foam retainer. The closed cell foam is utilized to account for the expansion and contraction of ice. The theory is that upon being cooled, ice will form first at the fins and progressly freeze toward the closed cell foam. The lid is constructed of aluminum plate stock and the gasket is a buna-N o-ring.

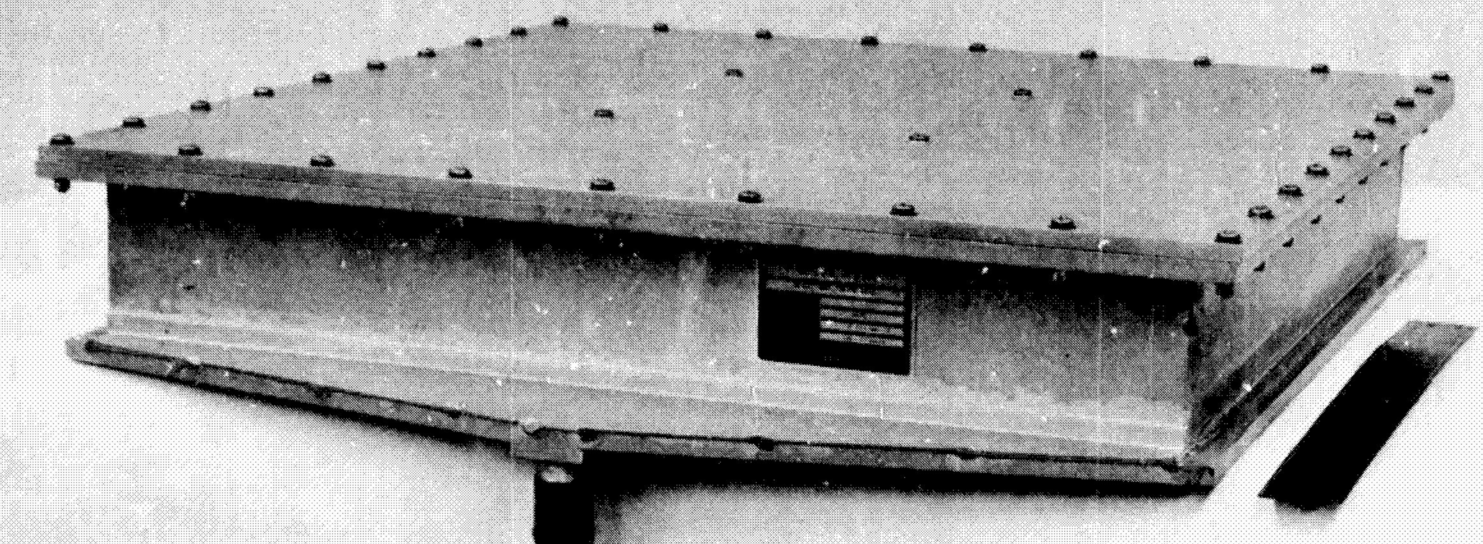
The wick is the means by which the water is transferred to the perforated sheet metal boiling surface during emergency operation; i.e., a wick-fed water boiler. Therefore, during normal operation the water is contained within the wick and is frozen within it. The progression of melt/freeze lines is depicted at the top of figure 10 from beginning to the end of the mission.

For emergency operation, the electrically actuated vacuum shut-off valve is activated, exposing the vapor exhaust to vacuum. When the vapor pressure at the perforated sheetmetal boiling surface falls to the saturation pressure consistent with the heat transfer input rate, boiling occurs. Vaporization also occurs at the fins to maintain pressure equalization and to fill the void formed by the water being wicked to the boiling heat transfer surface. A progression of vapor/liquid lines, as shown in figure 11, depicts the path the water will take within the wick from start to finish of the emergency mission mode.



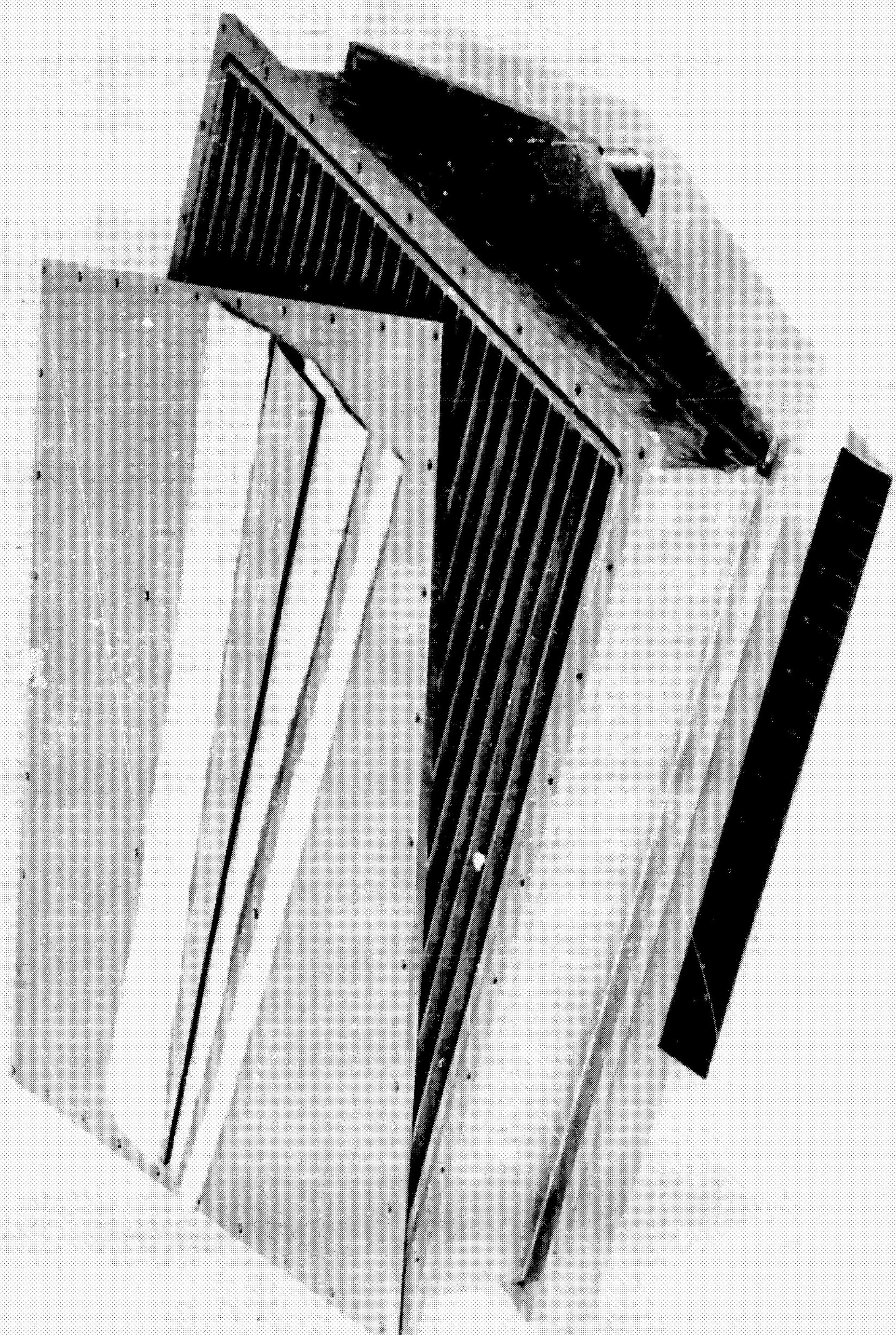
ICE CHEST/HEAT EXCHANGER – EMERGENCY OPERATING MODE

FIGURE 11



ICE CHEST FRONT VIEW

FIGURE 12



ICE CHEST - INTERNAL CONFIGURATION

FIGURE 13

PART IV

SECTION B

COOLANT LOOP

PUMP/MOTOR

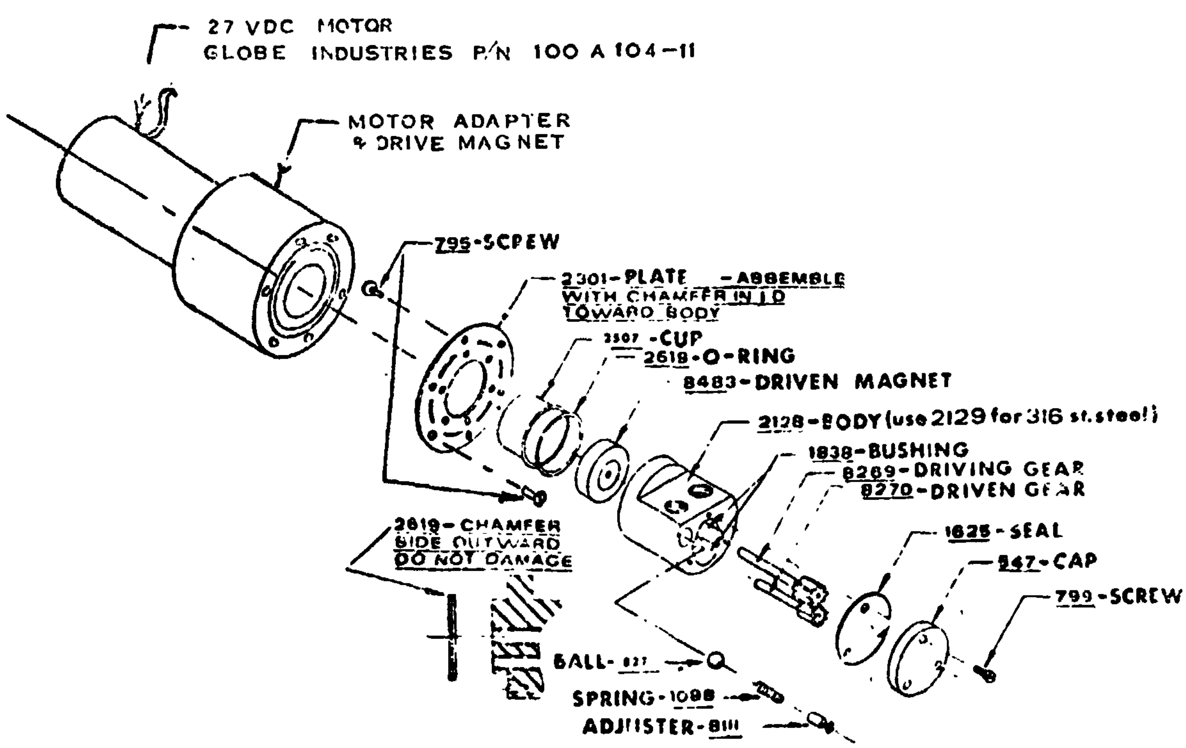
MICROPUMP P/N 12-31-316-814

A commercial pump/motor is used to provide the fluid circulation in the liquid coolant loop. This pump/motor, manufactured by Micropump Corporation as P/N 12-31-316-814, utilizes a 27 volt DC motor manufactured by Globe Industries as P/N 100A104-11 to drive a magnetic coupling, which in turn drives a gear pump. The gear pump has Teflon gears and static seals, and utilizes stainless steel for all other parts. By use of a magnetic coupling all dynamic seals are eliminated.

An internal bypass, contained within the pump to prevent motor damage due to overload, is set to crack at 20 psid.

PRECAUTION: Do not run this pump dry because dry running will greatly accelerate gear wear and may cause permanent damage.

An exploded view of the pump/motor is shown in figure 14.



MICROPUMP ®

PUMP/MOTOR

FIGURE 14

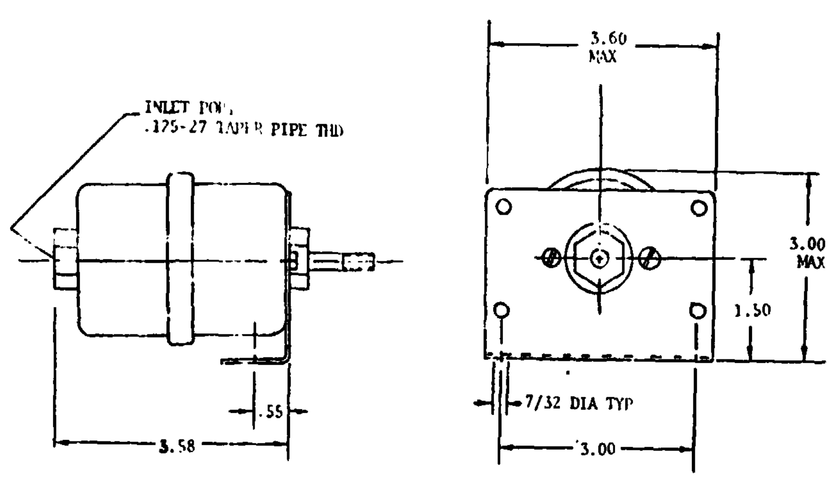
MICROPUMP CORPORATION 1021 SHARY COURT, CONCORD, CALIF. 94520

ACCUMULATOR

SVSK 86075

A modified commercial bellows type accumulator is used to pressurize the liquid coolant loop to a pressure level of 6 to 20 psi above ambient pressure. Additionally, this accumulator provides a means to compensate for thermal and mechanical expansion and contraction within the coolant loop components and fluid. This item consists of a Bellofram Corporation, B-711-3, commercial accumulator with a Lee Spring Company, LC125M-6, stainless steel spring inserted on the ambient side of the bellows to provide pressurization force. The Bellofram accumulator utilizes an aluminum body, nylon reinforced neoprene bladder, and stainless steel guide shaft.

Figure 15 illustrates the external configuration of the accumulator.



ACCUMULATOR EXTERNAL CONFIGURATION

FIGURE 15

METERING VALVES

WHITEY RESEARCH TOOL COMPANY P/N 6LRS6-316

A commercial metering valve is used for both the Bypass Flow Control Valve and the Heat Exchanger Flow Control Valve in the liquid coolant loop. This valve, manufactured by Whitey Research Tool Company as P/N 6LRS6-316, is made with a stainless steel body and a 0.250 inch orifice regulating stem. The flow characteristics and physical dimensions of this valve are shown in figure 16.

FIXED BYPASS VALVE

WHITEY RESEARCH TOOL COMPANY P/N 3LRF4-316

A commercial metering valve is used for the heat exchanger Fixed Bypass Valve in the liquid coolant loop. This valve, manufactured by Whitey Research Tool Company as P/N 3LRF4-316 is made with a stainless steel body and a 0.156 inch orifice regulating stem. The flow characteristics and physical dimensions of this valve are shown in figure 16.

WHITEY UNION BONNET REGULATING & SHUT-OFF VALVES

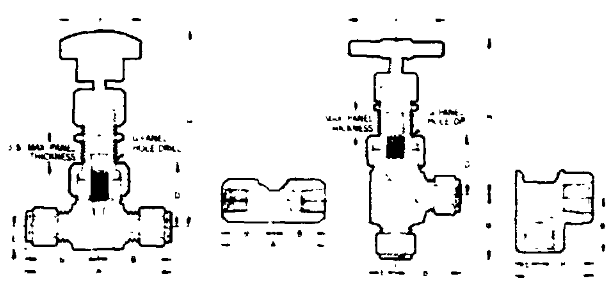
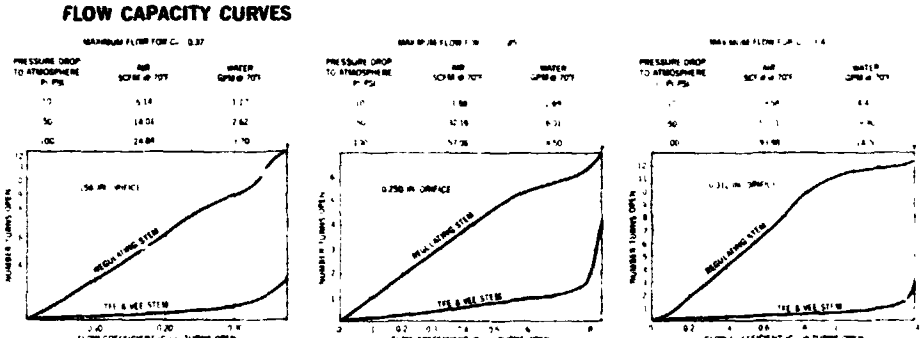


TABLE OF DIMENSIONS

UNION BONNET VALVES			CONNECTION SIZE	DIMENSIONS ②										
CATALOG NUMBER ①	STEM TYPE	ORIFICE (INCHES)	INLET AND OUTLET	A	B	B_1	B_2	C	D	E	F	G	H OPEN	H CLOSED
3LRF2 3TF2 3VF2	Regulating TFE Tip Vee	0.156	1/8 Female NPT	2	1	5/8	15/16	1 1/8	1 5/32	3/8	1 3/8	19/32	3 3/8	[illegible]
3LRF4 3TF4 3VF4	Regulating TFE Tip Vee	0.156	1/4 Female NPT	2 5/16	11/32	15/16	15/16	1 3/8	1 5/32 ③	3/8 ③	1 3/8	19/32	3 [illegible]	3 1/2
3LRS4 3TS4 3VS4	Regulating TFE Tip Vee	0.156	1/4 SWAGELOK	2 7/16	1 7/32	1 3/16	1 1/8	1 9/16	1 5/32	3/8	1 1/8	19/32	3 3/8	[illegible]
6LRF4 6TF4 6VF4	Regulating TFE Tip Vee	0.250	1/4 Female NPT	2 1/4	1 1/8	1 1/16	1 ④	1 3/8	1 11/32	1/2 ③	1 1/8	25/32	4 [illegible]	[illegible]
6LRS6 6TS6 6VS6	Regulating TFE Tip Vee	0.250	3/8 SWAGELOK	2 5/8	1 7/16	1 7/16	1 5/16	1 15/16	[illegible]	[illegible]	1 1/8	25/32	4 11/16	4 11/32
8RF6 8TF6 8VF6	Regulating TFE Tip Vee	0.312	3/8 Female NPT	2 5/8	1 5/16	1 3/8	1 3/8	2	1 5/8	5/8	2 1/2	29/32	4 5/8	4 7/32
8RF8 8TF8 8VF8	Regulating TFE Tip Vee	0.312	1/2 Female NPT	2 5/8	1 3/8	1 3/8	1 3/8	2	1 5/8	5/8	[illegible]	29/32	4 5/8	4 7/32
8RS8 8TS8 8VS8	Regulating TFE Tip Vee	0.312	1/2 SWAGELOK	3 7/16	1 23/32	1 23/32	1 17/32	2 9/32	1 5/8 ④	5/8	2 1/2	29/32	4 5/8 ④	4 7/32 ④

① For a complete ordering number add B for brass or SS for 316 stainless steel as a prefix to the catalog number. Add A as a suffix for angle pattern valves. Example SS 3LRF4 SS-6VF4 A ② Dimensions shown with SWAGELOK nuts finger tight when applicable ③ Add 1/16" for angle pattern valves ④ Subtract 1/16" for angle pattern valves

FLOW CAPACITY CURVES



WHITEY COMPANY • 5679 Landregan Street • Oakland, California 94662

VALVE FLOW CHARACTERISTICS
AND PHYSICAL DIMENSIONS

FIGURE 16

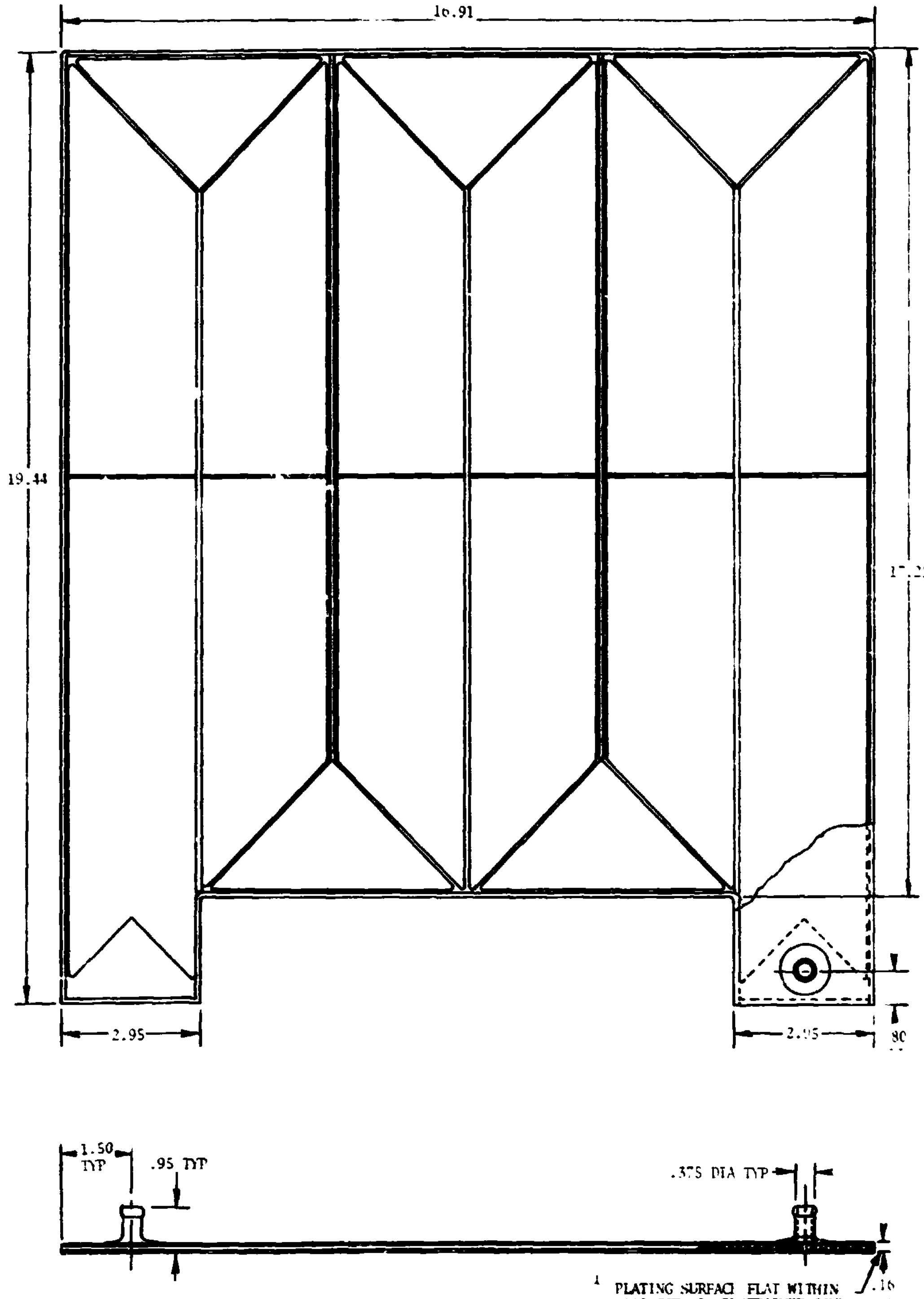
17

LIQUID COOLING GARMENT HEAT EXCHANGER

SVSK 86020

A custom designed, aluminum, six-pass, plate-fin, single passage heat exchanger is used to remove heat, generated in the liquid cooling garment (not supplied), from the liquid coolant loop. During operation this heat exchanger is held in intimate contact with the Ice Chest thereby allowing heat energy to be transferred through the heat exchanger /ice chest interface and into the Ice Chest. The heat exchanger is a flux-less brazed assembly utilizing 0.075 inch high, 0.003 inch thick fins with a fin count of 24 per inch. Headering between passes is accomplished by an internal headering arrangement consisting of fins cut and fitted at right angles with internal pass separation separating the flow in adjacent passages. The end sheet facing the Ice Chest, the heat transfer surface, is finish machined after brazing to ensure flatness. A 0.004 inch thick layer of lead is electroplated on the flat surface, to provide a soft surface ensuring good thermal contact.

Figure 17 illustrates the Liquid Cooling Garment Heat Exchanger configuration.



NOTE: (1) RESTRAINED CONDITION MAY BE OBTAINED BY APPLYING 3-5 PSI DISTRIBUTED CLAMPING LOAD.

LIQUID COOLING GARMENT HEAT EXCHANGER

FIGURE 17

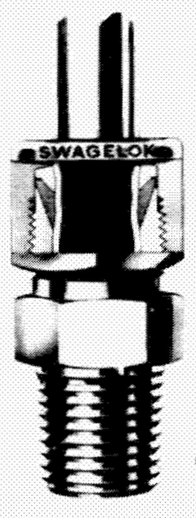
HYDRAULIC/PNEUMATIC FITTINGS AND LINES

Swagelok fittings manufactured by Crawford Fitting Company have been used throughout in conjunction with aluminum tubing to plumb the liquid coolant loop and the nitrogen bladder pressurization loop. Figures 18 thru 21 illustrate a description of Swagelok fittings as presented by the manufacturer's catalog.

All hydraulic lines utilized in the Ice Pack Heat Sink Subsystem are 3/8 inch OD, 0.049 inch wall, AA5052-TO aluminum hydraulic tubing. All pneumatic lines are 1/2 inch OD, 0.035 inch wall, AA6061-T6 aluminum hydraulic tubing.

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION

Here's How The SWAGELOK FITTING Functions



SWAGELOK Tube Fittings provide a leak-proof, torque-free seal at all tubing connections and eliminate costly, hazardous leaks in instrumentation and process tubing.

In the illustration, notice that the tubing is supported ahead of the ferrules by the fitting body. Two ferrules grasp tightly around the tube with no damage to the tube wall. There is virtually no constriction of the inner wall insuring minimum flow restriction. Exhaustive tests have proven that the tubing will yield before a SWAGELOK Tube Fitting will leak.

The secret of the SWAGELOK Tube Fitting is that all the action in the fitting moves along the tube axially instead of with a rotary motion. Since no torque is transmitted from the fitting to the tubing, there is no initial strain which might weaken the tubing.

The SWAGELOK patented sequential action overcomes variations in tube materials, wall thickness and hardness by its double ferrule inter-action. Ferrule inter-action thus overcomes most of the variables which cause other fittings to fail.

SWAGELOK Tube Fittings are easily installed with no special tools. See the installation instructions on page 27.

CHECKLIST FOR EXCELLENCE IN TUBE FITTINGS

Design

A Tube Fitting Should . . .

- Be **self-aligning.**
- Work on **thick or thin** wall tubing.
- Have **tube support** ahead of the seal to resist vibration.
- Work on **any tube** material.
- Have all components made of the **same material** as the fitting body for thermal compatibility and corrosion resistance.
- Have a **residual spring** condition so that temperature cycling will not cause leakage.
- Seal on **machined surfaces.**
- Seal between ferrule and body at a point **different from where the heavy work** is performed.
- **Compensate** for the normal variables encountered in tubing materials.
- **Not** create torque or leave a **residual strain** on the tubing.
- **Not weaken** the tube wall.
- **Not** significantly **reduce** flow area.

Performance

A Tube Fitting Should . . .

- Contain any pressure up to the burst point of the tubing **without leakage.**
- Work on **vacuum** as well as **low** or **high** pressures.
- Seal **consistently at cryogenic** temperatures.
- Seal **consistently at elevated** temperatures up to the maximum tubing temperature rating.
- Seal **consistently over a wide range of** temperature cycling.
- Seal repeatedly under **make-and-break** conditions.

Assembly

A Tube Fitting Should . . .

- Use **geometry rather than torque** for uniformity of make-up (1-¼ turns).
- **Not** require **disassembly and inspection** before or after initial make-up.
- **Not require special tools** for assembly.

Service

A Tube Fitting Should . . .

- Be **readily available** in all sizes, materials, end connections and configurations from local distributor stocks, with substantial back-up stocks to support distributor inventories.
- Be designed, manufactured, sold, and serviced by experienced **tube fitting specialists** who understand and respect the need for reliable performance.

CRAWFORD FITTING COMPANY/29500 SOLON ROAD/CLEVELAND, OHIO 44139

CRAWFORD FITTINGS (CANADA), LTD., NIAGARA FALLS, ONTARIO

SWAGELOK FITTING CHARACTERISTICS

FIGURE 18

Swagelok Tube Fittings

AVAILABLE IN ALL MACHINEABLE METALS AND PLASTICS FOR PRESSURE AND VACUUM SERVICE

Component parts of SWAGELOK Tube Fittings are all made of the same material

SUMMARY OF TYPES OF SWAGELOK FITTINGS

Fitting Type Designator	Type of Fitting	See Catalog Page No.
-1-	Male Connector	7
-2-	Male Elbow	8
-3-	Tee, Union	16
-3TTF	Tee, Female Branch	12
-3TFT	Tee, Female Run	12
-3TTM	Tee, Male Branch	9
-3TMT	Tee, Male Run	9
-4-	Cross, Union	16
-5-	Male Elbow	8
-6	Union	14
-6-	Reducing Union	15
-7-	Female Connector	10
-8-	Female Elbow	11
-9-	Union Elbow	15
-11-	Bulkhead Male Connector	7
-61	Bulkhead Union	14
-71-	Bulkhead Female Connector	10
-A	Male Adapter	8
-A1	Bulkhead Adapter	18
-A-F	Female Adapter	11
-A-OR	O-Seal Straight Thread Adapter	23
-C	Cap	20
-P	Plug	20
-1-OR	O-Seal Straight Thread Connector	23

Fitting Type Designator	Type of Fitting	See Catalog Page No.
-R-	Reducer	18
-OR	After Male Connector Part Number Indicates O-Seal Male Connector Pipe Thread	22
-OR	After Male Adapter Part Number Indicates O-Seal Male Adapter Pipe Thread	23
-MPW (Suffix)	Male Pipe Weld	21
-TSW (Suffix)	Tube Socket Weld	21
-AN (Suffix)	AN Connection	17
-ANF (Suffix)	AN Adapter or Female Connection	19
--1	Fitting Body Only (Example: 401)	8–11
--2	Nut (Example: 402)	25
--3--	Front Ferrule (Example: 403)	25
--4--	Back Ferrule (Example: 404)	25
--5--	Insert (Example: 405)	26
--6	Special AN Insert (Example: 406)	--
--7	Male Nut (Example: 407)	--
--8	Adapter Bushing (Example: 408)	--

[illegible] MATERIAL DESIGNATOR Codes, see page 28
[illegible]
[illegible] see page 28

 CRAWFORD FITTING COMPANY/29500 SOLON ROAD/CLEVELAND, OHIO 44139

SWAGELOK FITTING TYPES

FIGURE 19

Swagelok Tube Fittings

AVAILABLE IN ALL MACHINEABLE METALS AND PLASTICS FOR PRESSURE AND VACUUM SERVICE

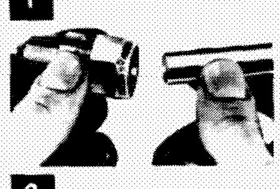
Component parts of SWAGELOK Tube Fittings are all made of the same material

SWAGELOK Tube Fittings come to you completely assembled, finger-tight. They are ready for immediate use. Disassembly before use can result in dirt or foreign material getting into the fitting and causing leaks.

INSTALLATION INSTRUCTIONS

SWAGELOK Tube Fittings are installed in three easy steps.

1

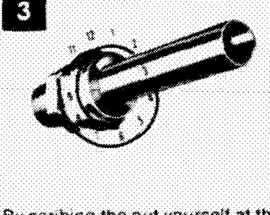


STEP 1
SIMPLY INSERT THE TUBING INTO THE SWAGELOK TUBE FITTING. MAKE SURE THAT THE TUBING RESTS FIRMLY ON THE SHOULDER OF THE FITTING AND THAT THE NUT IS FINGER-TIGHT.

2

STEP 2
BEFORE TIGHTENING THE SWAGELOK NUT, SCRIBE THE NUT AT THE 6:00 O'CLOCK POSITION.

3



STEP 3
NOW, WHILE HOLDING THE FITTING BODY STEADY WITH A BACKUP WRENCH, TIGHTEN THE NUT ONE-AND-ONE-QUARTER TURNS*. WATCHING THE SCRIBE MARK, MAKE ONE COMPLETE REVOLUTION AND CONTINUE TO THE 9:00 O'CLOCK POSITION.

By scribing the nut yourself at the 6:00 o'clock position *as it appears to you*, there will be no doubt as to the starting position. When tightened 1¼ turns to the 9:00 o'clock position you can easily see that the fitting has been properly installed.

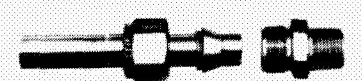
High Pressure Applications:

Due to the variation of tubing diameters, a common starting point is desirable. Therefore, use a wrench to snug up the nut until the tubing will not turn (by hand) in the fitting. At this point, scribe the nut and body of the fitting. Now tighten the nut one-and-one-quarter turns and *the fitting is ready to hold* pressures high enough to yield the tubing.

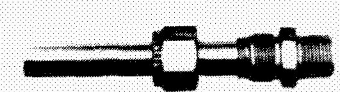
*For 1/16", 1/8" and 3/16" size tube fittings, only 3/4 turn from finger-tight is necessary.

RE-TIGHTENING INSTRUCTIONS

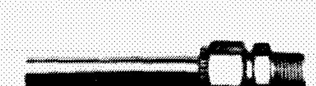
Connections can be disconnected and re-tightened many, many times and the same reliable, leak-proof seal obtained every time the reconnection is made.



FITTING SHOWN IN DISCONNECTED POSITION



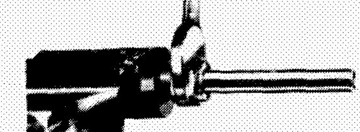
TUBING WITH PRE-SWAGED FERRULES INSERTED INTO THE FITTING UNTIL FRONT FERRULE SEATS IN FITTING



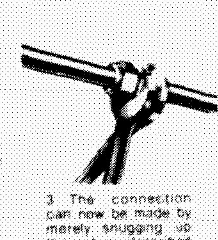
TIGHTEN NUT BY HAND. ROTATE NUT ABOUT ONE-QUARTER TURN WITH WRENCH (OR TO ORIGINAL ONE-AND-ONE-QUARTER TIGHT POSITION), THEN SNUG SLIGHTLY WITH WRENCH.

PRE-SWAGING INSTRUCTIONS

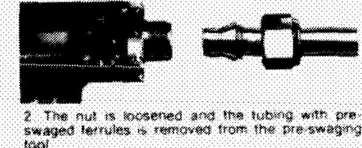
When SWAGELOK Tube Fittings are to be installed in cramped quarters or overhead where ladders must be used, it is sometimes found advantageous to use a pre-swaging tool on the tubing in an open ground area, thus pre-swaging the ferrules onto the tubing. The tubing is then removed from the pre-swaging tool and the tubing (with nut and pre-swaged ferrules) *can now* be attached to a fitting merely by following the re-tightening instructions.



1. Assemble SWAGELOK nut and ferrules to pre-swaging tool. Insert tubing and tighten nut one-and-one-quarter turns.



3. The connection can now be made by merely snugging up the nut as described in the re-tightening instructions.



2. The nut is loosened and the tubing with pre-swaged ferrules is removed from the pre-swaging tool.

When ordering be sure to specify material. *See page 28 for complete ordering information.*

CRAWFORD FITTING COMPANY/29500 SOLON ROAD/CLEVELAND, OHIO 44139

27

SWAGELOK FITTING INSTALLATION

FIGURE 20

How to order SWAGELOK tube fittings

TYPICAL SWAGELOK PART NUMBERS

MATERIAL	MATERIAL DESIGNATOR		TUBE SIZE DESIGNATOR (SIXTEENTHS/INCH)		TYPE OF FITTING DESIGNATOR (page 6)		REDUCED SIZE OR TYPE OF END CONNECTION (SIXTEENTHS/INCH)	SEE CATALOG PAGE
Brass	B	–	600	–	1 (Male Connector)	–	4 (¼" Male Pipe)	7
Steel	S	–	1610	–	9 (Union Elbow)			15
316 Stainless Steel	SS	–	810	–	6 (Union)	–	4 (¼" Reduced Tube Size)	15
Aluminum	A	–	401	–	A (Adapter)	–	2 (⅛" Male Pipe)	8
Monel	M	–	600	–	2 (Male Elbow)	–	4 (¼" Male Pipe)	8
Nylon	NY	–	810	–	6 (Union)			14
TFE	T	–	400	–	1 (Male Connector)	–	4 (¼" Male Pipe)	7

Ordering Instructions

The numbering system for SWAGELOK Tube Fittings is designed so that all catalog numbers are prefixed by a MATERIAL DESIGNATOR Code followed by a dash. Examples: B-(Brass), S-(Steel), SS-(316 Stainless Steel), A-(Aluminum), M-(Monel), NY-(Nylon), T-(TFE).

The SIZE DESIGNATOR following the dash indicates the tubing size in sixteenths of an inch.

After the next dash is the TYPE OF FITTING DESIGNATOR. (See page 6). This number or letter identifies the TYPE OF FITTING (such as male connector, union elbow, reducing union, tee, adapter, etc.)

After the next dash is the REDUCED SIZE or TYPE OF END CONNECTION (if it differs from the first end), also in sixteenths of an inch.

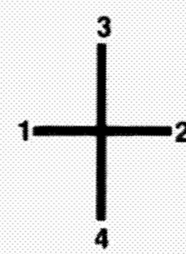
For Tube Fittings over 1", see Tube Fittings (over 1") subsection of Master Catalog Binder.

For a complete list of Material Designator Codes, see reverse side of "FITTINGS" divider in Master Catalog Binder.

Tees and Crosses

TEES are described by first sizing the run (1 to 2) and then the branch (3). CROSSES are described by first sizing the run (1 to 2) and then the branch (3 to 4).

Example: B-600-3TTF (See page 12) (Brass Female Branch Tee)



MONEL—T.M. International Nickel. TYGON—T.M. U.S. Stoneware Company.

SWAGELOK FITTING PART NUMBERS

FIGURE 21

PART IV

SECTION C

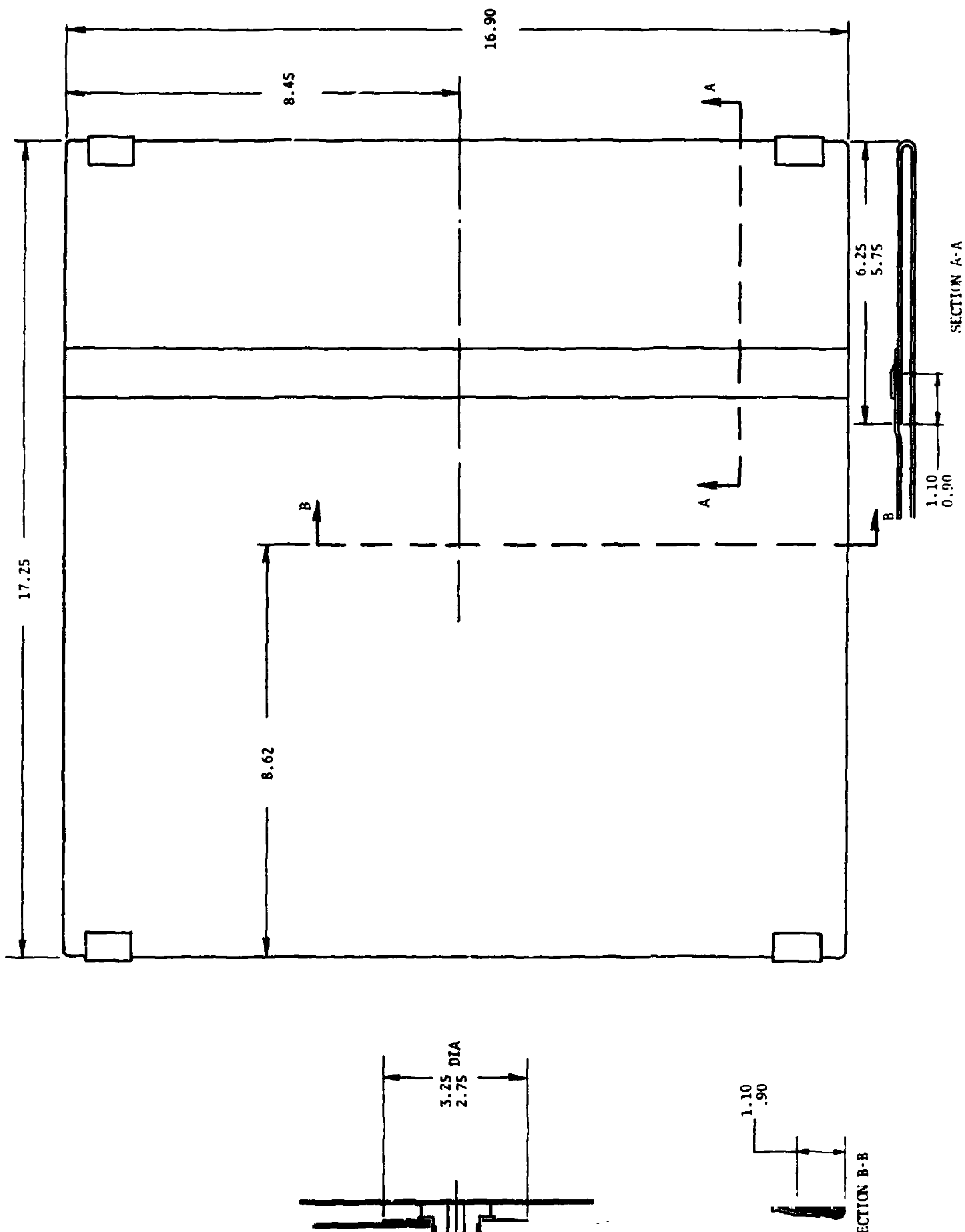
PRESSURIZATION BLADDER

BLADDER

SVSK 86098-100

The bladder (diaphragm) was constructed by Hamilton Standard to provide a means for holding the LCG heat exchanger in contact with the heat transfer surface of the Ice Chest. Nitrogen pressure of 8 psig is introduced into the bladder by means of a nylon fitting in the bottom center of the bladder. The bladder is constructed of nylon reinforced neoprene coated bladder material. All seams are overlapped one inch and bonded with Ubagrip adhesive. Each seam is further stitched with nylon thread,and nylon reinforced neoprene coated one-inch wide tape is Ubagrip-bonded over the stitching to provide a pressure tight seam.

Figure 22 illustrates the bladder configuration.



BLADDER CONFIGURATION

FIGURE 22

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION

PART IV

SECTION D

VACUUM LOOP

VACUUM SHUT-OFF VALVE

JAMESBURY CORPORATION P/N 1 1/2" A3300TT MOD B/EJ20 27 VDC ACTUATOR

A commerical shut-off valve and valve actuator are used to perform the vacuum passage control function for the normal mode/emergency mode operating conditions of the Ice Chest. During normal mode operation the valve is closed, thereby preventing the ice chest vapor passages from being vented to vacuum. Upon a signal from the valve controller the valve opens and vents the ice chest vapor passages to vacuum, thereby causing the water within the Ice Chest to boil and provide emergency cooling capacity.

The Vacuum Shut-Off Valve is manufactured by Jamesbury Corporation as P/N 1 1/2" A3300TT, MOD B/EJ20, 27 VDC ACTUATOR and is a ball-type valve. The valve body, ball, and associated hardware are made of stainless steel and the valve seals are of teflon TFE. Inlet and outlet fittings are 1 1/2 inch internal pipe threads. A 27 VDC actuator with travel limit switches and visual position indicator switches rotates the ball to obtain either a full shut-off condition or a full open condition upon delivery of an electrical signal from the valve controller. Each of these two conditions is indicated by an appropriate pilot light located on the front panel of the Ice Pack Heat Sink Subsystem Console. The actuator has a die-cast, explosion-proof aluminum cover that acts as a mechanical and dust protector but allows the actuator pressure to equalize to that of the ambient condition. Actuator materials and construction allow operation in a hard vacuum environment.

Figures 23 and 24 illustrate information obtained from the valve vendor relating to the valve.

jamesbury "Double-Seal"

Available in BRONZE Type A-11

CARBON STEEL Type A-22

303 STAINLESS Type A-33

316 STAINLESS Type A-36

ALUMINUM Type A-44

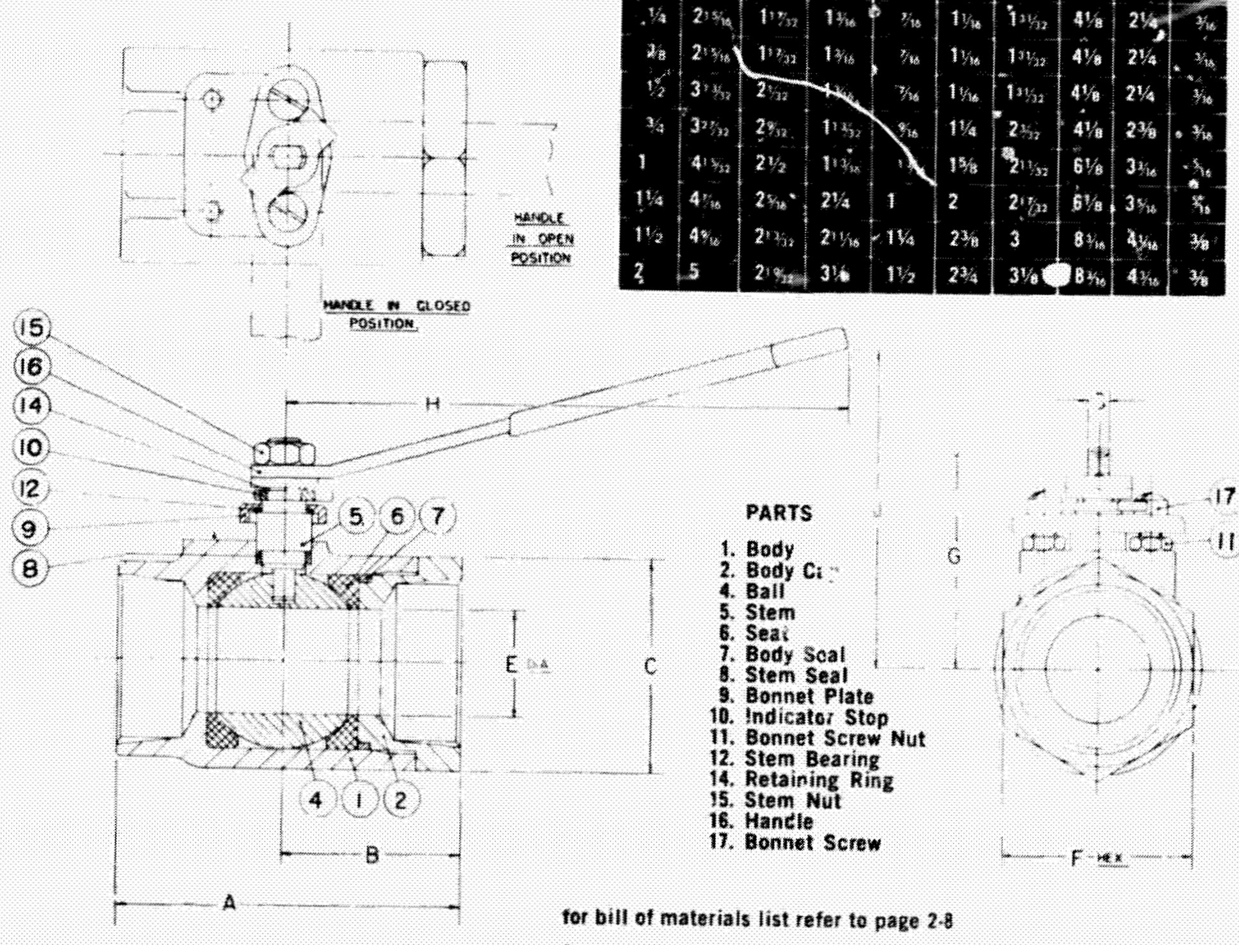
MONEL Type A-71

(for 3" design in Bronze, Carbon Steel, 316 Stainless Steel and Aluminum, please refer to page 2-5)

The range of available materials allows selection of the most economical type of valve for either non-corrosive or corrosive services according to performance requirements. Hard coating of aluminum trim and chrome plating of trim in all other materials offer excellent abrasion resistance. Interchangeability of parts means valves can be provided with balls and stems of materials differing from that of valve bodies for special applications. A full range of seat and seal materials fits all service conditions of media, cycling, pressure and temperature.

APPROXIMATE DIMENSIONS IN INCHES

Valve Size	A	B	C	E	F	G	H	J	S Blade
1/4	2 15/16	1 17/32	1 3/16	7/16	1 1/16	1 31/32	4 1/8	2 1/4	3/16
3/8	2 15/16	1 17/32	1 3/16	7/16	1 1/16	1 31/32	4 1/8	2 1/4	3/16
1/2	3 13/32	2 1/32	[illegible]	7/16	1 1/16	1 31/32	4 1/8	2 1/4	3/16
3/4	3 27/32	2 9/32	1 15/32	9/16	1 1/4	2 3/32	4 1/8	2 3/8	3/16
1	4 13/32	2 1/2	1 13/16	[illegible]	1 5/8	2 11/32	6 1/8	3 3/16	3/16
1 1/4	4 7/16	2 5/16	2 1/4	1	2	2 17/32	6 1/8	3 5/16	5/16
1 1/2	4 9/16	2 13/32	2 11/16	1 1/4	2 3/8	3	8 3/16	4 3/16	3/8
2	5	2 19/32	3 1/8	1 1/2	2 3/4	3 1/8	8 3/16	4 3/16	3/8



PARTS

1. Body
2. Body Cap
4. Ball
5. Stem
6. Seat
7. Body Seal
8. Stem Seal
9. Bonnet Plate
10. Indicator Stop
11. Bonnet Screw Nut
12. Stem Bearing
14. Retaining Ring
15. Stem Nut
16. Handle
17. Bonnet Screw

for bill of materials list refer to page 2-8

for pressure temperature ·· s — refer to page 2-9

VACUUM SHUT-OFF VALVE CHARACTERI...

FIGURE 23

jamesbury "Double-Seal" **BALL VALVES**

EJ20 and EJ50 ELECTRIC OPERATORS

Designed and manufactured by Jamesbury expressly to actuate "Double-Seal" valves. EJ operators offer the assurance of completely unequalled reliability. They can be obtained already assembled on valves or can be easily installed on Jamesbury valves already in service without any modifications.

OPTIONAL FEATURES

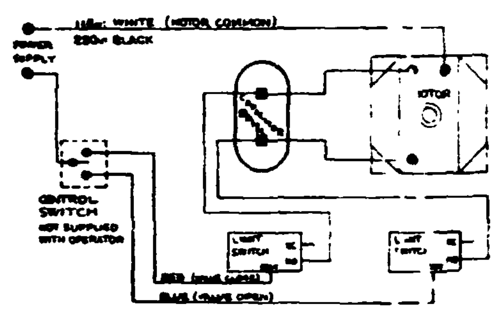
For applications between +40° and −40° F, internal space heaters can be furnished, preventing condensation of moisture within the operator. Heater rating: 115 v 100 watt.

When limit switches are required, two integral cut-off switches within the operator can be used to indicate valve open and valve closed provided the signal devices use the same electrical input as the operator. Additional limit switches with completely independent circuits can be installed. Ratings for these are:

115 v - 230 v 60 cycle AC	10 amp. s
30 v DC	10 amp. s
125 v DC	.5 amp.
250 v DC	.25 amp.

Potentiometers are available for mounting within the operator to record or read out the exact valve position at any intermediate setting.

WIRING SCHEMATIC
EJ OPERATOR



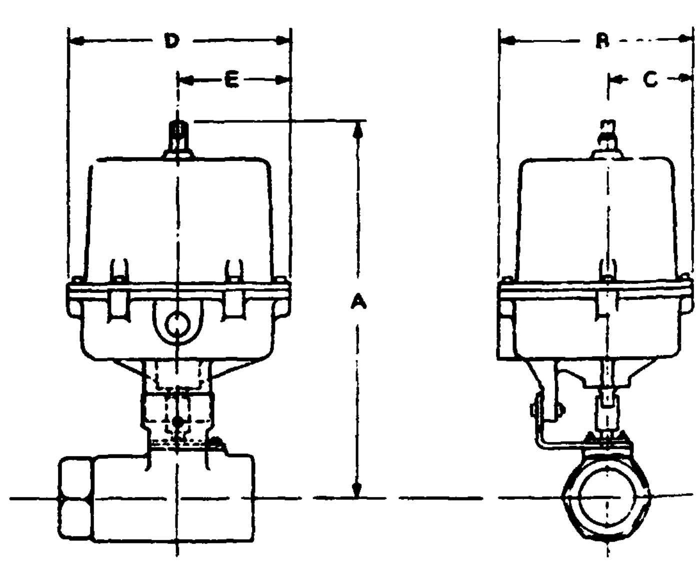
VALVE CENTERLINE TO TOP OF OPERATOR
DIMENSIONS IN INCHES

DIMENSION A FOR EJ 20 MOUNTED ON				
Valve Size	All A, AZ, AT Valves	All Flanged Valves	D88 DW88	HP HT
1/4"	10 3/8	N/A	N/A	10 5/8
3/8"	10 3/8	N/A	N/A	10 5/8
1/2"	10 3/8	10 7/16	11 5/16	10 5/8
3/4"	10 1/2	10 [illegible]/16	11 5/16	11 3/16
1"	10 3/4	11	12 1/8	11 7/16
1 1/4"	10 15/16	11 1/16	12 9/16	11 13/16
1 1/2"	11 1/8	11 1/2	12 3/8	11 15/16
2"	11 1/2	11 5/8	12 13/16	12 3/16

For EJ 50, add 5/8" to above dimensions for EJ 20

OTHER DIMENSIONS

EJ 20				EJ 50			
B	C	D	E	B	C	D	F
5 1/2	2 7/8	6	[illegible]	5 3/4	2 3/4	6 5/8	3 [illegible]/16



VACUUM SHUT-OFF VALVE CHARACTERISTICS
FIGURE 24

PART IV

SECTION E

ELECTRICAL LOOP

POWER SUPPLY

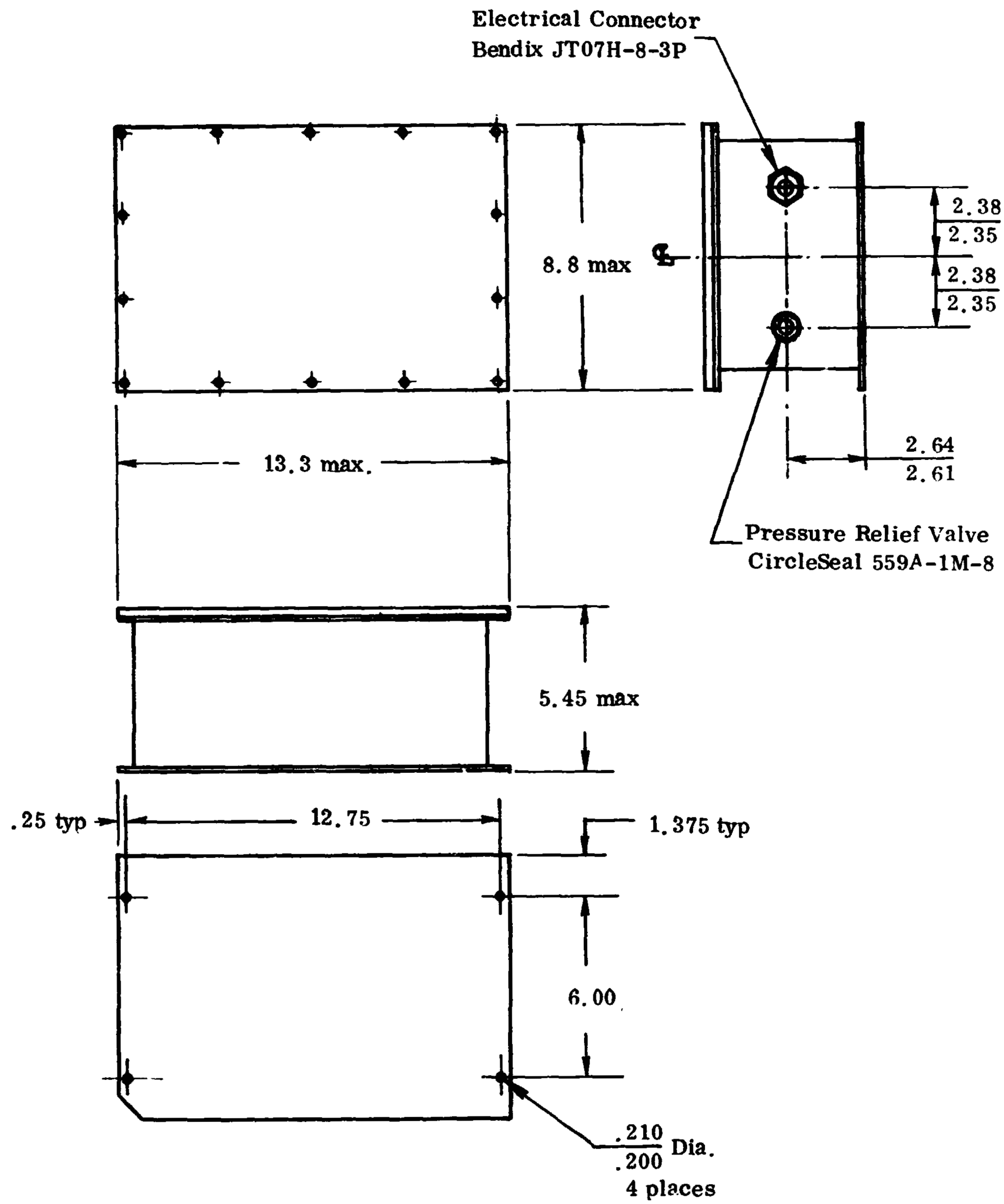
SVSK 86112

A self-contained rechargeable power supply is utilized to provide electrical power for operation of the Ice Pack Heat Sink Subsystem. This Power Supply consists of 18 commercial Yardney Electric Division P/N LR20DC-3 silver-zinc alkaline battery cells connected in series to produce a nominal voltage of 27 VDC and a nominal capacity of 20 ampere-hours.

The power supply case and cover are anodized aluminum and are so constructed with a Buna-N cover seal, to provide a pressure tight container for the battery cells. A pressure relief valve, James, Pond & Clark Circle Seal P/N 559A-1M-8, is incorporated to maintain a pressure in the case of 8 psia minimum during vacuum operation and to provide pressure relief for the case in the event of a pressure build-up due to cell malfunction.

Refer to the Power Supply Maintenance and Recharge Section of this manual for power supply handling procedures and precautions.

Figure 25 illustrates the external configuration of the power supply.



POWER SUPPLY

FIGURE 25

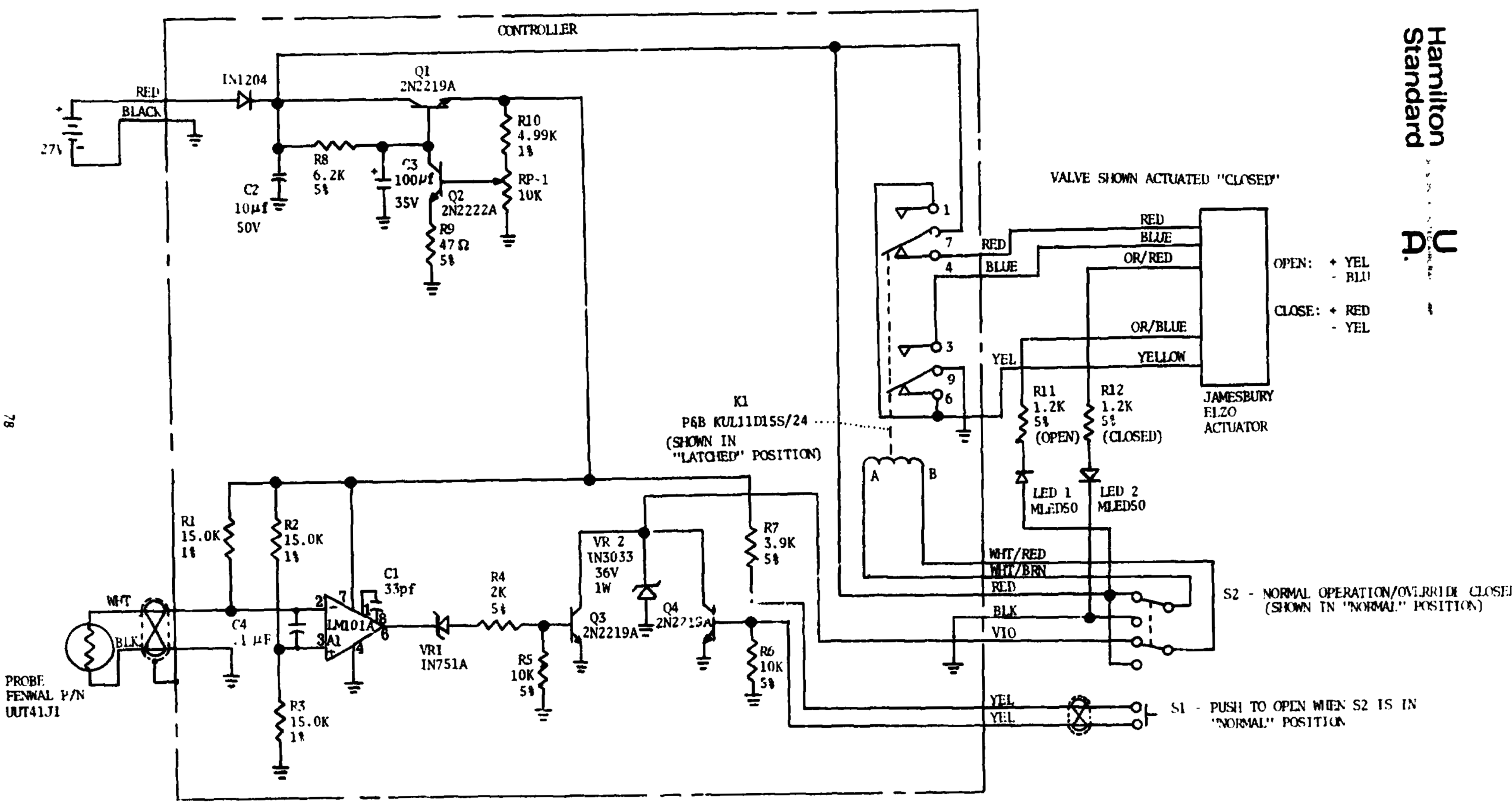
VALVE CONTROLLER

SVSK 86206

The Valve Controller, designed and manufactured by Hamilton Standard, consists of DC valve control circuitry triggered by a thermistor temperature probe signal or by external override switches to provide an electrical signal which operates a valve actuator, thereby providing positioning of the Vacuum Shut-Off Valve. Except for an electromechanical relay used to switch power to the valve actuator, solid state circuitry is used exclusively. The controller uses a nominal voltage of 27 volt DC and is designed to operate over the entire power supply voltage range of 19.8 to 32.8 volt DC. The circuitry is reverse polarity protected using a series diode. The temperature sensor bridge and comparator circuits are powered by the + 15 volt regulated output of a series regulated circuit. An LM 101A operational amplifier performs the comparison function directly off the resistance bridge on which one leg is the thermistor. The comparator output is level-shifted and fed to a transistor switch. A second transistor switch is controlled by the override open switch. These two transistor switches are connected in a logic "OR" configuration. The override closed switch has a "normal position" setting to permit active control by the thermistor electronics. Overriding the valve closed is accomplished by placing this switch in the override closed position which causes the valve to close and disables the override open circuitry.

The electromechanical relay switches the power supply voltage from the valve controller through the terminal box to the proper valve actuator coil with the appropriate polarity. Indicator lamps are wired from the valve actuator through the terminal box to provide open/closed position indications.

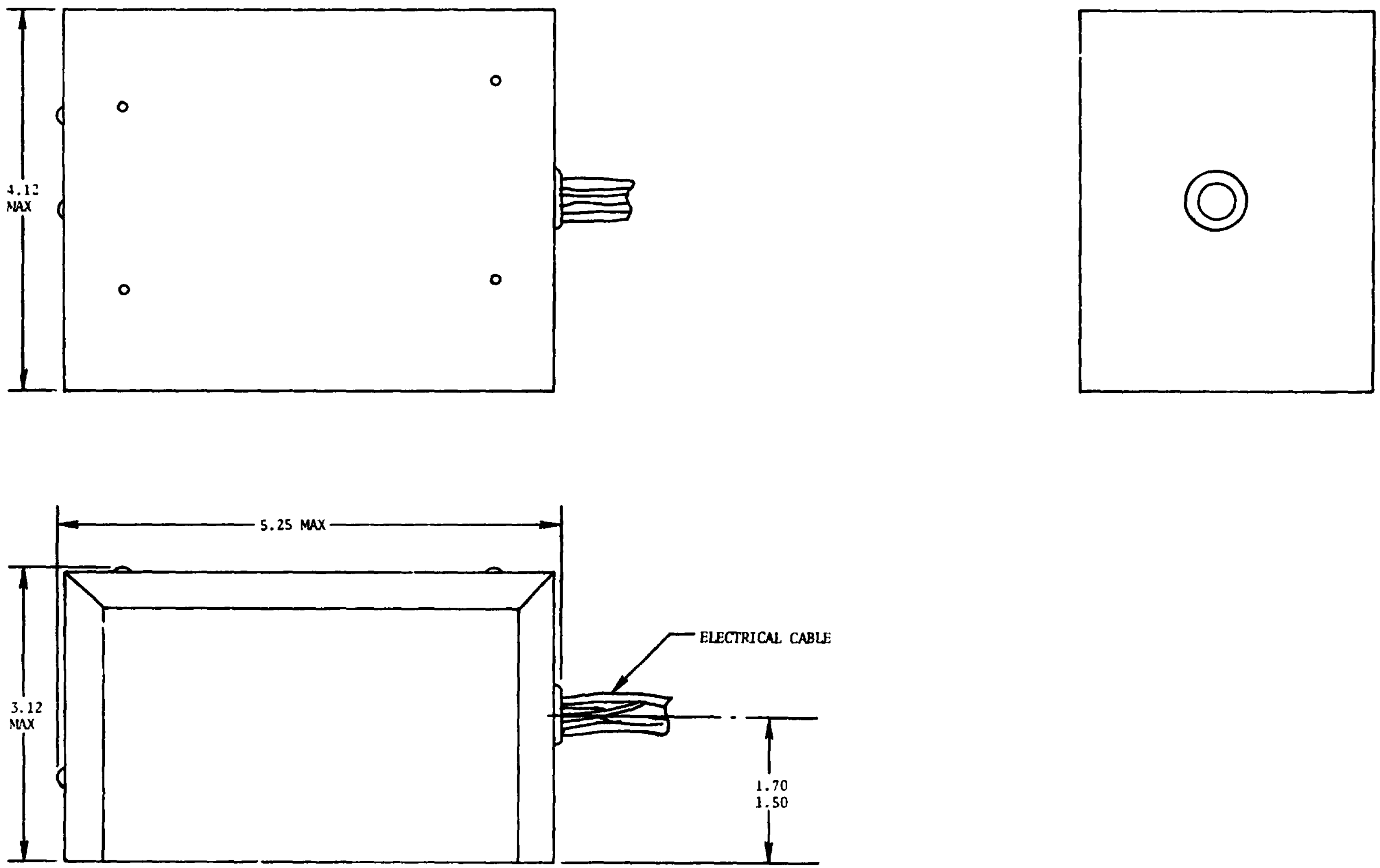
Figure 26 illustrates the valve controller electrical schematic and Figure 27 illustrates the valve controller external configuration.



VALVE CONTROLLER ELECTRICAL SCHEMATIC

FIGURE 26

Hamilton Standard



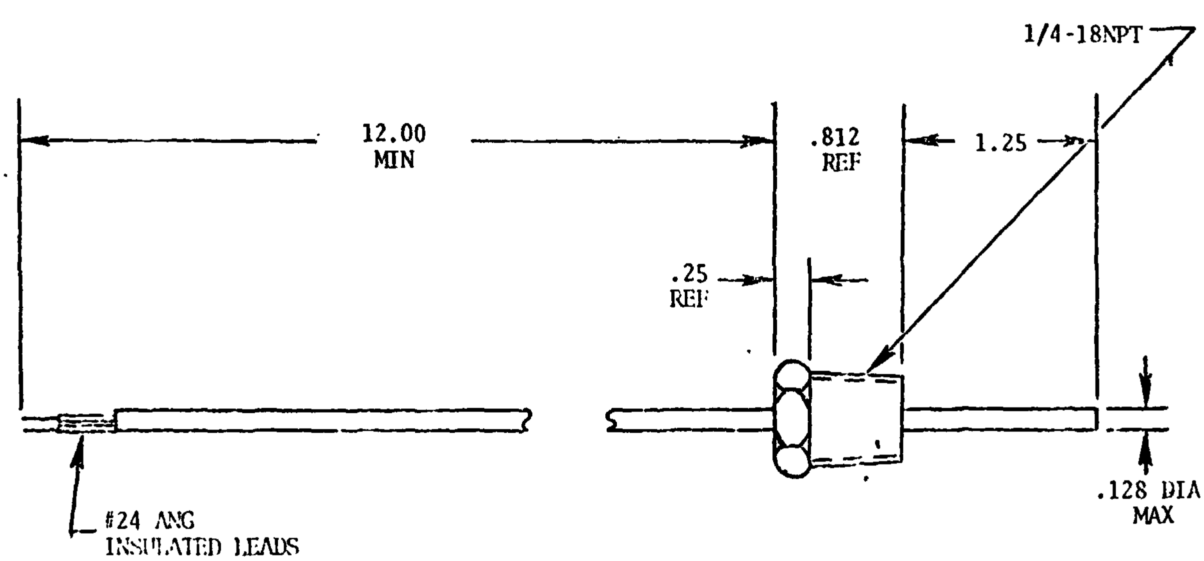
VALVE CONTROLLER EXTERNAL CONFIGURATION
FIGURE 27

THERMISTOR

SVSK 86166

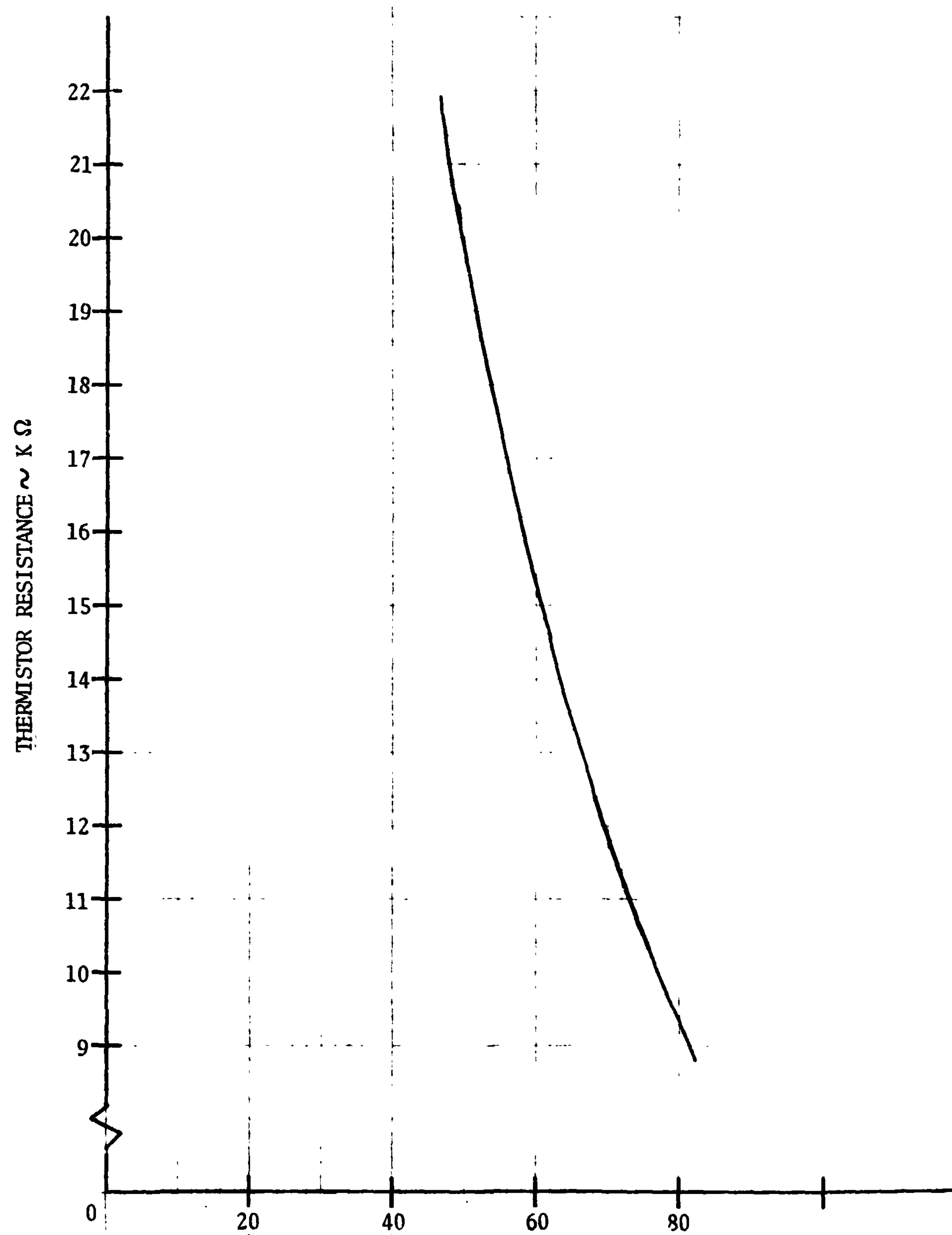
A commercial thermistor is utilized to provide the electrical signal to the Valve Controller, SVSK 86206, and to indicate the liquid cooling loop heat exchanger outlet temperature. This thermistor, manufactured by Fenwal Electronics, Inc., as P/N H33/UUA41J, contains an element hermetically sealed in a stainless steel housing. The thermistor element produces an electrical resistance of 15.3 K ohm at a liquid coolant loop temperature of 60°F, as shown in the Resistance versus Temperature curve of figure 29.

Figure 28 illustrates the thermistor external configuration.



THERMISTOR EXTERNAL CONFIGURATION

FIGURE 28



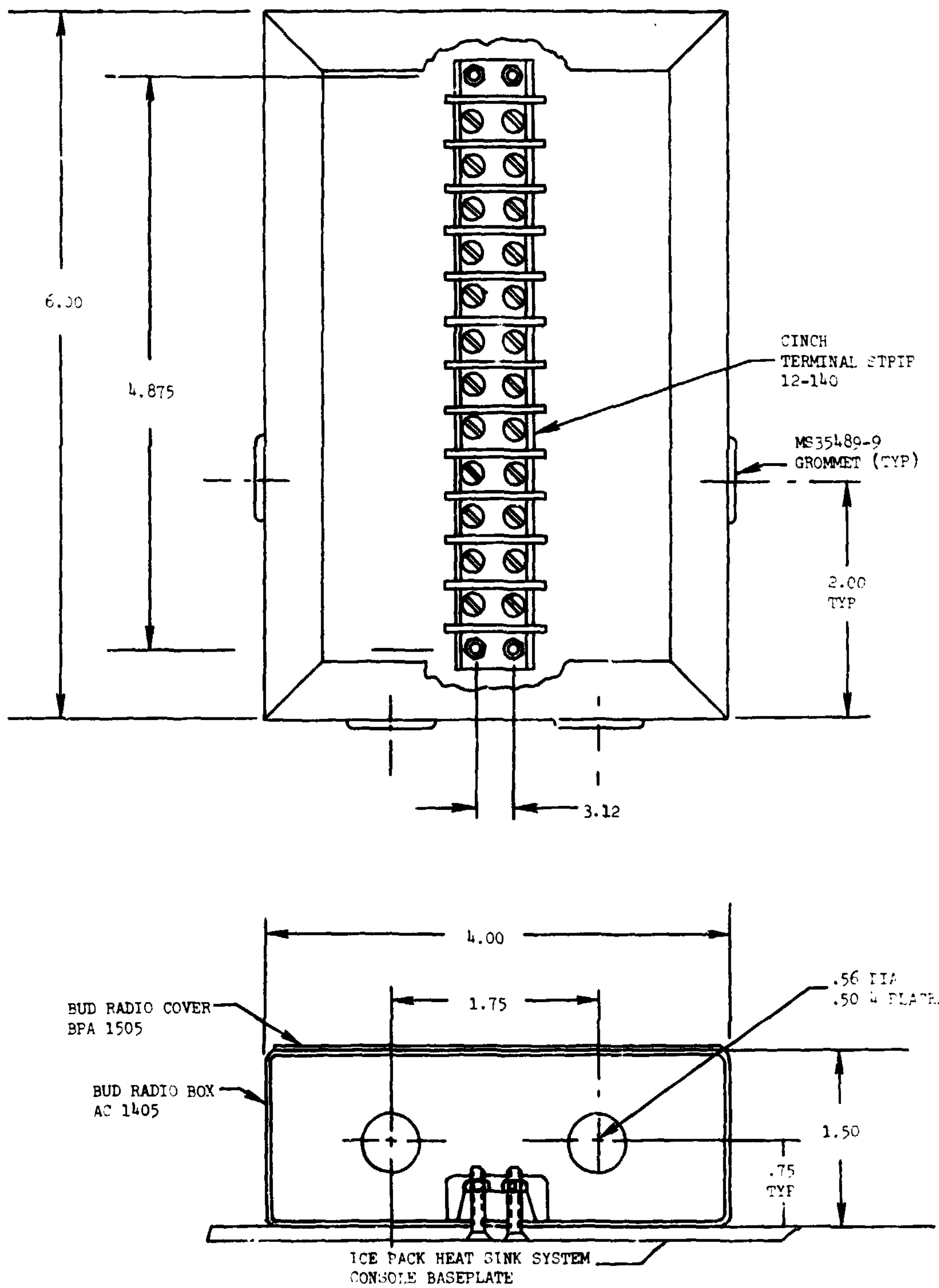
RESISTANCE VS TEMPERATURE
FENWAL H33/UUA41J THERMISTOR

FIGURE 29

THERMOCOUPLES

The thermocouples utilized to monitor console inlet temperature, console outlet temperature, and LCG heat exchanger outlet temperature are manufactured by Advanced Products Company and are as follows:

Thermocouple Element:	Shielded and ungrounded copper - constantan ISA "T"
Shell:	Stainless steel welded shell 1/8" diamter x 2" long



TERMINAL BOX

FIGURE 30

TERMINAL BOX

The terminal box assembly was fabricated utilizing a Bud Radio Company aluminum box P/N AC 1405, and cover P/N BPA 1505, a Cinch terminal strip P/N 12-140, and four MS35489-9 rubber grommets.

Wiring within the Ice Pack Heat Sink Subsystem is routed per the electrical block diagram figure 3 in such a manner that all interconnections between components are junctioned within the terminal box. Thus any component, except as noted below, may be removed separately without requiring splicing of wires.

EXCEPTION: The override open and override closed switches are wired directly to the controller and must be removed with the controller if controller removal is required.

Figure 30 illustrates the terminal box configuration.